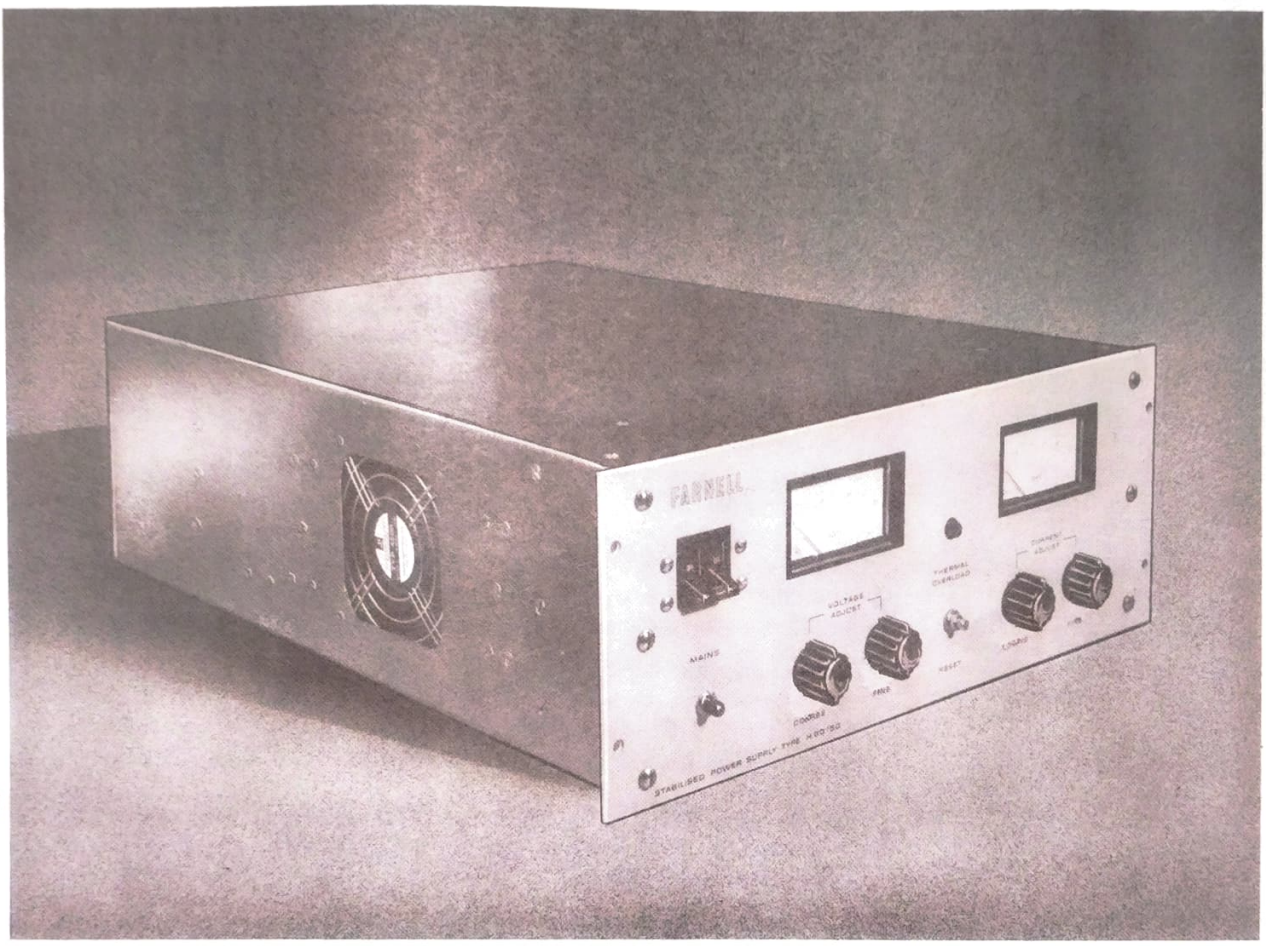
Publication PS 7

Farnell

heavy duty power supplies



H60/50 0-60V, 0-50A
H60/25 0-60V, 0-25A
H30/100 0-30V, 0-100A

Constant voltage/constant current operation with automatic crossover of mode

Remote programming facility

Remote voltage sensing provided

Master/slave connections

These heavy duty, regulated d.c. supplies will provide either constant voltage or constant current. Changeover of operating mode is automatic, the transition point being determined by the settings of the voltage and current controls and the load resistance.

Designed for systems and laboratory use, they are intended for mounting into a 19″ rack or cubicle. Preregulation and forced air cooling by internal fans has enabled height to be kept to a minimum.

A thermal trip is fitted as a safeguard and if the airflow is restricted or a fan failure occurs, the unit automatically shuts-down. Indication of shut-down is provided by the illumination of a lamp in the centre of the front panel. A reset button is provided to return the unit to normal operation when the cause of over-heating has been rectified.

Connections

All external connections are made at the rear of the unit and terminals are provided for:

a) the master/slave parallel operation of several units where higher currents are required.

b) series connection of two units where up to 120 volts is required.

c) remote sensing of the load to compensate for the voltage drop across the leads connecting unit to load to ensure optimum performance at the load rather than at the output terminals of the unit.

d) to allow remote operation of the power supply by a duplicate set of controls or programming resistors and remote metering of voltage and current. The programming coefficient is approximately 420 ohms per volt for CV operation and 20 ohms per amp for CI operation.

Circuit description

Pre-regulator

Pre-regulation has been employed to minimise internal power dissipation. The action of the pre-regulator is to vary the unregulated d.c. line in step with output voltage by keeping the voltage across the series regulator constant for all load conditions. Thus in the case of the H60/50 model, whether the load is 50A at 60V or 50A at 1V the unit internal dissipation is the same.

S.C.R. control

The pre-regulator system employed is of the 'phase controlled rectifier' type. The S.C.R. firing circuit consists of a variable ramp generator synchronised to twice the supply frequency which is controlled by a potential divider sensing the voltage across the series regulator stage. The output from the ramp generator drives a Schmitt trigger circuit, the output of which is applied to the S.C.R.'s via a pulse output stage.

Auxiliary supply and thermal overload circuitry

The auxiliary supply provides voltages for the control amplifier and reference circuits. Also included on the same circuit board is the thermal overload circuitry. Regulator heatsink temperature is sensed by a thermistor which provides a signal for a Schmitt trigger circuit. At a heatsink temperature of approximately 100°C, the Schmitt changes state and causes an S.C.R. to conduct, lighting the front panel warning lamp and feeding a shutdown signal to the control amplifiers. Providing that the cause of overheating has been remedied and sufficient cooling time has been allowed, normal operation can be regained by pressing the reset button on the front panel.

Control amplifiers

a) Voltage reference and C.V. amplifier

This circuit consists of a differential amplifier which compares a proportion of the output voltage (derived from a resistive potentiometer) with a voltage reference source.

Any change in output voltage produces a differential signal at the amplifier input. This signal is amplified and applied to the drive amplifier in such a sense as to oppose the original change.

b) Current reference and C.I. amplifier

Function similar to above except variation of output current causes the voltage across a current sensing resistor to change. This changing voltage is compared with a reference source as before and the difference amplified and fed to the drive amplifier to oppose the original change.

c) Shut-down and short circuit protection amplifier

In the event of a sudden short circuit being applied to the unit output terminals, the pre-regulator having a slower response time than the CV and CI amplifiers, cannot keep pace with output voltage and the d.c. line voltage appears across the series regulator. A protection amplifier is provided to reduce output current to a safe level until the pre-regulator has had time to adjust to the new conditions. Part of this circuitry serves also as the thermal overload shut-down amplifier which prevents output current being drawn when a shut-down signal is received from the thermal overload circuit.

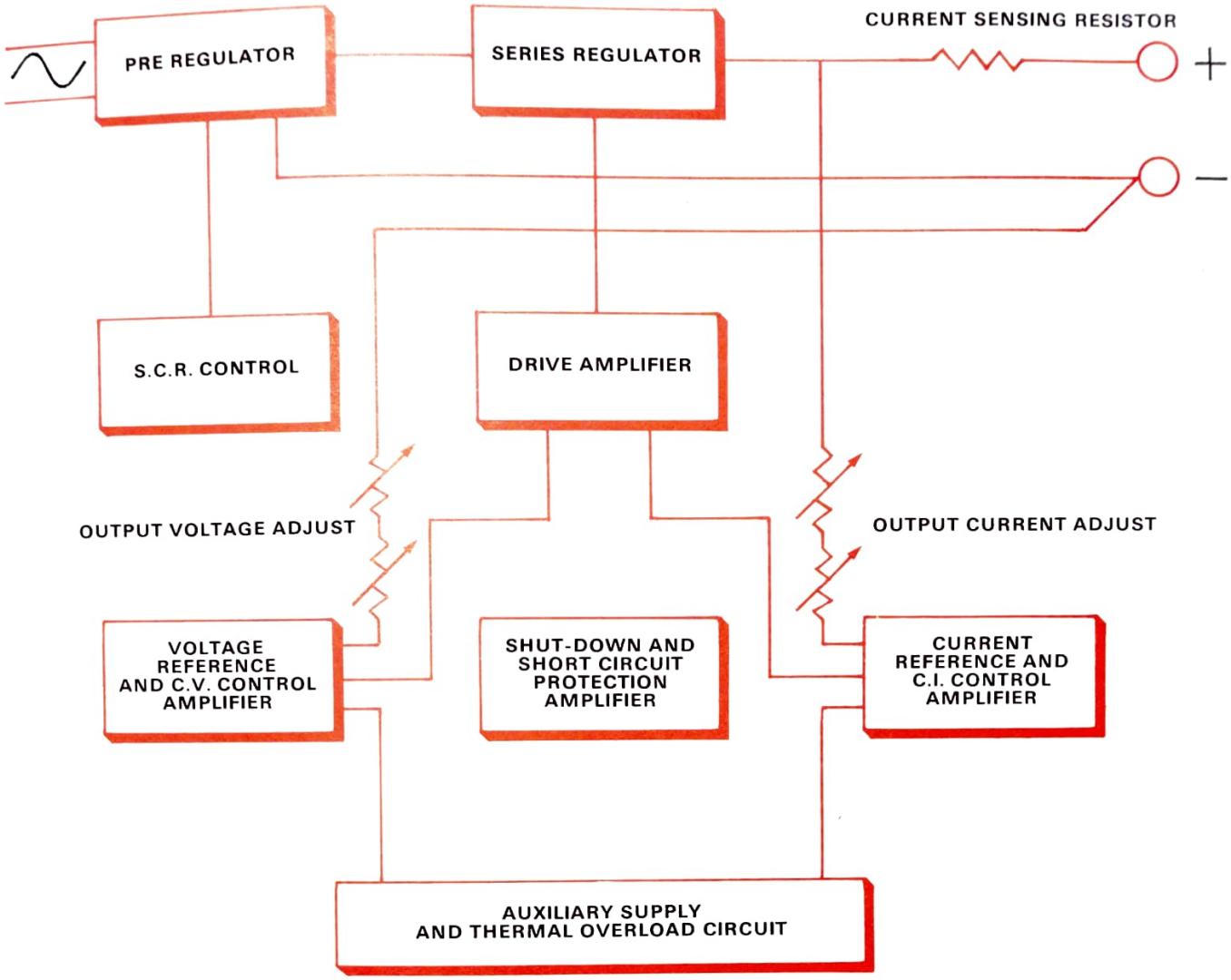
d) Drive amplifier

Further amplification of the signals from the CV, CI and shut-down amplifiers is provided by the drive amplifier before being passed to the series regulator.

Series regulator

This comprises parallel connected emitter followers driven by cascaded emitter followers.

Schematic diagram



Pre-installation notes

Prior to installation or use, the instruction manual provided should be carefully read. The following brief notes may answer possible queries about installation.

Mains input

At full load on 240V inputs, the supply point for H60/50 must be capable of providing 23 amps r.m.s. For 220 volts operation, the supply rating must be 25 amps r.m.s. and if a 110 volt version has been supplied, the supply rating must be 50 amps r.m.s. The 100A model will draw 28A r.m.s. from the supply.

Mechanical

The weight of the unit is carried by its side panels and support runners should be provided directly under them capable of supporting the weight. The front panel must not support any appreciable weight.

When mounted in a cubicle, provision must be made for adequate air intake and exit.

When connecting several units in the master/slave configuration and mounting them one on top of another in a cubicle it is not necessary to remove the covers from the units. Recirculatory air currents within the cubicle should be prevented by baffles. At full current output the power dissipation in each 50A model is 600 watts and the air temperature passing through it is raised by 20-30°C. For six units operating at full load in one cubicle an air supply of 170m³/hour (100 cu. ft/min) would be needed and therefore in an extreme case like this, an additional extractor fan must be fitted in the cubicle. These figures are halved for the 25A model.

Specification

Mains input
H60/25 H60/50
0—220, 240 volts 50/60 Hz. Factory preset
0–110 volts version to special order
H30/100
0–209 to 258V. 50/60 Hz 28A r.m.s.
110V NOT available

Mains variation tolerated ± 7½%
(H60/25, H60/50)

Output

Model	Voltage	Current
H60/50	0–60V	0–50A
H60/25	0–60V	0–25A
H30/100	0–30V	0–100A

Line regulation
(output change for a ± 7½% mains change)
Constant voltage less than ·01% + 200uV
Constant current less than ·01% + 2·4mA

Load regulation
(output change for a zero to full load change)
Constant voltage less than ·01% + 200uV
Constant current less than ·01% + 2·4mA

Stability typical
Constant voltage.
Total drift for 8 hours after 1 hour warm up period at constant ambient temperature is less than ·02% + 2mV.
Constant current.
As above, less than ·02% + 5mA.

Ripple and noise content
at full load (Δf = 10kHz)
Constant voltage less than 1mV r.m.s.
Constant current less than 10mA r.m.s.
(50mA on 100A model)

Output impedance (C.V.) typical
Less than
·001Ω from d.c. to 100Hz
·01Ω from 100Hz to 1kHz
·2Ω from 1kHz to 100kHz
2Ω from 100kHz to 1MHz

Transient recovery time (typical)
Less than 50uS for output to recover within 20mV following a zero to 50% load change of 1uS rise time

Temperature coefficient (typical)
Constant voltage ·02% + 1mV per °C
Constant current ·02% + 5mA per °C

Operating ambient temperature range 0–50 °C

Storage temperature range
–20 °C to + 50 °C

Cooling
Forced air cooling by internal fans. Thermal overload protection

Dimensions approx. overall
H60/50
Height 17·8 cm (7")
Width 48·25 cm (19")
Depth 62·0 cm (24")

H60/25
Height 17·8 cm (7")
Width 48·25 cm (19")
Depth 50·8 cm (20")

H30/100
Height 26·7 cm (10½")
Width 48·25 cm (19")
Depth 51·0 cm (21")

Weight
H60/50
79 kg (174 lbs.)

H60/25
60 kg (144 lbs.)

H30/100
86 kg (190 lbs.)

Note: The above specification is for a unit connected for normal operation.

Represented by:

Manufactured in England by:

Farnell

FARNELL INSTRUMENTS LIMITED
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WEST YORKSHIRE LS22 4DH
TELEPHONE 0937 63541 · TELEX 557294

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Printed in England.

INSTRUCTION BOOK FOR

'H' SERIES POWER SUPPLY UNITS

FARNELL INSTRUMENTS LIMITED . SANDBECK WAY . WETHERBY . YORKSHIRE LS22 4DH TELEPHONE 0937-3541 . TELEX 557294

SCHEDULE OF EQUIPMENT

The unit has been carefully packed to prevent damage in transit. When you remove the unit from the box, be sure that you remove all parts and accessories from the packing material.

The complete equipment comprises:-

a) 1 off power supply

b) 1 off instruction book

c) 1 off returnable (otherwise chargeable) packing case

Note:- In the event of damage in transit or shortage in delivery, separate notices in writing should be given to both the carriers and Farnell Instruments Ltd., within three days of receipt of the goods, followed by a complete claim within five days. All goods which are the subject of any claim for damage in transit or shortage in delivery should be preserved intact as delivered, for a period of seven days after making the claim, pending inspection or instructions from Farnell Instruments Ltd., or an agent of this Company.

INTRODUCTION

The Farnell 'H' series are 'heavy-duty' regulated d.c. power supplies giving either constant voltage or constant current output. Changeover from one mode of operation to the other is automatic and the point at which changeover takes place is continuously adjustable by front panel controls. Indication of output is provided by two front panel meters, one measuring output voltage and the other output current.

The supply will operate from mains inputs of 240 volts 50/60Hz only. (Units to operate from 220 volts 50/60Hz can be supplied on request).

Since the 'H' series are physically heavy units and can be operated in several different modes, the following notes on installation and operation should be carefully read and understood before use.

INSTALLATION

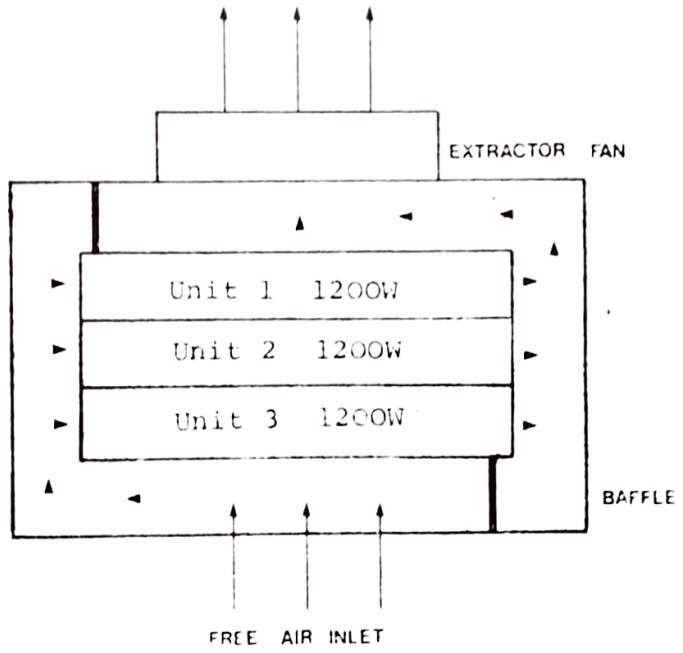
The weight of the unit is carried on its side panels and support runners should be provided directly under them, capable of supporting the weight of the unit. The front panel must not support any appreciable weight.

Units may be operated one on top of another without removing the covers.

As the units are cooled by forced air the construction of any cabinet into which the units may be fitted must allow adequate air intake and exit. Recirculation of air must be prevented by baffles (see fig. 1). At full current output, the power dissipated within the unit raises the temperature of the air passing through it by 20-30 °C. Air intake is on one side of the unit and exit on the other.

Take the case of three H30/100's operating at full load in one cabinet. Air should enter and leave the cabinet at approximately 170 m^3/hour (100 cu. ft. per minute) and to do this, an additional fan in the cabinet would be necessary.

EXAMPLE



Dissipation per unit

H60/25	300w
H60/50	600w
H30/100	1200w

OPERATING INSTRUCTIONS

WARNING

Care should be taken to ensure that the mains input setting as indicated on the label on the rear of the unit is compatible with the intended input voltage.

Connection to the mains is by the studs on the rear of the unit marked L, N, E i.e. Mains live, Mains neutral, Earth. Units are normally supplied for 240 volts operation unless otherwise requested. As a filter is incorporated in the input circuitry, a good earth is essential.

Normal operation

At the rear of the unit, link terminals:-

(1) B, C and J
(2) D, E and F
(3) G, H and K

Connection to the load is via the studs on the rear of the unit marked 'O/P+' and 'O/P-'.

Output voltage and current are adjusted by the 'coarse' and 'fine' controls on the front panel marked 'Voltage adjust' and 'Current adjust'.

The unit will operate as a constant voltage source for load resistances greater than the resistance given by V set/I set, where V set is the setting of the unit output voltage and I set is the setting of the unit output current.

For load resistances less than V set/I set, the unit will operate as a constant current source. The changeover from constant voltage to constant current is automatic.

Thermal trip

The unit is protected against the effects of restricted air flow or fan failure and will automatically shut down if internal overheating occurs. Indication of shutdown is provided by the illumination of the lamp in the centre of the front panel. In order to reset the unit after shutdown (provided that the cause has been rectified) sufficient time should elapse for the unit to cool (approximately 3 minutes with the fans running) and the reset button on the front panel pressed and released. The unit will reset to correct operation.

Remote programming operation (resistive)

Units may be externally programmed in either constant voltage, constant current or both, by means of external resistors.

a) Constant voltage

Connection of the terminals at the rear of the unit is as follows:-

Link terminals (1) B, C and J
(2) D, E and F
(3) H and K

Turn the 'Voltage adjust' controls fully anticlockwise or short them out internally.

Connect the programming resistor between terminals G and K.

The programming coefficient is approximately 840Ω/volt for 30V units and 420Ω/volt for 60V units, but can be varied slightly by means of internal adjustment of the programming current source, trimmer P1 on the control amplifier circuit board.

N.B. Stable, low noise, low temperature coefficient resistors of at least ¼ watt rating should be used and connection from the unit to the programming resistor should be made via a twisted pair of wires.

b) Constant current

Connection of the terminals at the rear of the unit is as follows:-

Link terminals (1) B, C and J
(2) D and F
(3) G, H and K

Connect the programming resistor between terminals A and F. The programming coefficient is approximately 10Ω/amp for H30/100, 20Ω/amp for H60/50 and 40Ω/amp for H60/25, but can be varied slightly by means of an internal adjustment of the programming current source, trimmer P2 on the control amplifier circuit board.

N.B. Stable, low noise, low temperature coefficient resistors of at least ¼ watt rating should be used and connection from the unit to the programming resistor should be made via a twisted pair of wires.

Remote programming operation (voltage)

Units may be externally programmed in either constant current or constant voltage or both, by means of an externally applied voltage.

a) Constant current

At the rear of the unit link terminals as follows:-

(1) B, C and J
(2) D and E
(3) G, H and K

Turn current controls fully clockwise and use voltage controls normally. Connect the programme voltage between terminal B, positive, and negative via an external resistor to terminal D. The resistor should allow a maximum current of approximately 1mA which corresponds to maximum output current.

b) Constant voltage

At the rear of the unit link terminals as follows:-

(1) B, C and J
(2) D, E and F
(3) H and K

Turn voltage controls fully anticlockwise and use current controls normally. Connect the programme voltage negative to terminal B and positive via an external resistor to terminal G. The resistor should allow a maximum current of approximately 1mA for 30V units and 2mA for 60V units, and this corresponds to maximum output voltage. Also connect an external 27kΩ ½W resistor between terminals G and H and open circuit the flexible wire link between pins 12 and pin 4 on the control amplifier circuit board mounting socket accessible behind the unit's front panel.
N.B. Normal operation of the front panel voltage controls is not possible until the wire link between pins 12 and 4 is replaced.

Remote sensing (constant voltage only)

Where it is required to compensate for the voltage drop across the leads connecting the load to the unit i.e. maintaining a constant voltage at the load and not at the unit output terminals, use may be made of the remote sensing facilities.

Connection of the terminals at the rear of the unit is as follows:-

Link terminals (1) C and J
(2) D, E and F
(3) G and H

Connect terminal B to the positive output lead at the load, twisting the wire round the output lead.

Connect terminal G to the negative output lead at the load, twisting the wire round the output lead. An electrolytic capacitor of approximately 4000μF 60V WKG should be connected directly across the load in order to reduce overshoot and undershoot following transient load changes. It may be found necessary to decouple terminal B to the positive output terminal and terminal G to the negative output terminal, (to stop instability) at the unit with an electrolytic capacitor. The value of capacity required is indeterminate as it depends upon the conditions in the particular installation.

Since the resistance of the positive output lead is now in series with the current sensing resistor it will be found necessary to adjust P2 on the control amplifier circuit board so that with the 'CURRENT ADJUST' controls fully clockwise full output current can be obtained with the load short circuited.

Series operation

Units may be connected directly in series in order to give a greater voltage range. Output current capability will be determined by the supply set to the lowest current. It is recommended that no more than two supplies be connected in this manner.

Parallel operation

A master/slave configuration is used when a current greater than that available from a single supply is required.

Connection of the terminals at the rear of the unit is as follows:-

The master supply is connected as for a single supply (normal, or remotely programmed).

On the slave supply (ies)

Link terminals (1) A and D
(2) B and J
(3) G, H and K

Terminal C on the slave unit is connected to terminal A on the master unit.

Output voltage and current is controlled by the master supply only, provided that the 'VOLTAGE ADJUST' controls on the slave units are turned fully clockwise.

N.B. Since the voltage drop of the positive output lead from each supply is added to the current sensing voltage for each supply, the following method of connection for MASTER/SLAVE systems should be used.

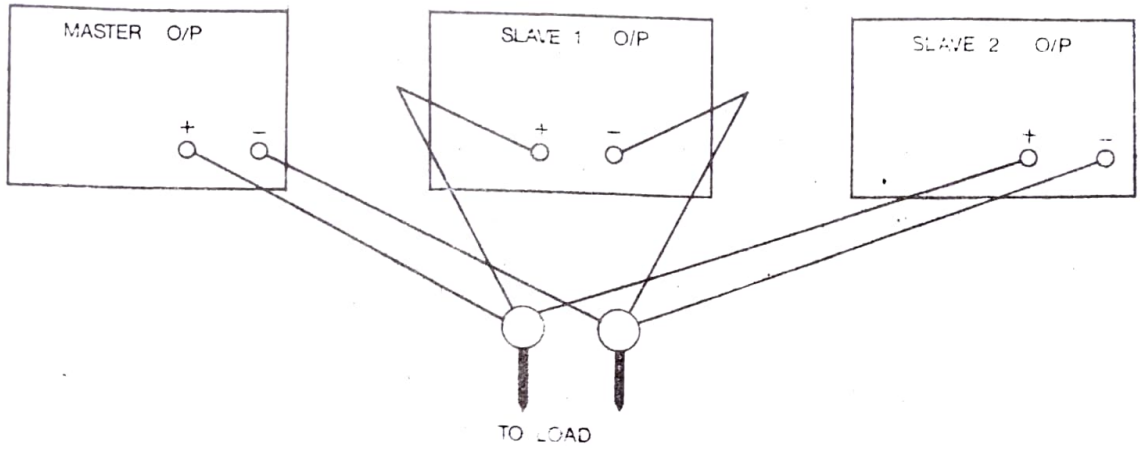
(1) The positive output lead from each unit should be taken to a common connection, as near to the units as possible. These leads should be of equal rating and equal length and as short as possible.

Similarly:-

(2) The negative output lead from each unit should be taken to a common connection, as near to the units as possible. These leads should be of equal rating and equal length and as short as possible.

(3) The load connection leads should be taken to the common positive and negative connections.

Current sharing should be checked by measuring the voltage across terminals A and B on each unit. The voltages should be equal to within 1%.



External meters

Connection to an external voltmeter should be made to terminals J and K when normal operation is used or across the load when remote sensing is used. (Terminal J is positive with respect to terminal K).

A signal of 0 to approximately 1 volt corresponding to 0-full load is available at terminals A and B (terminal A being positive with respect to B). Connection may be made from these terminals to a meter of 1mA full scale deflection, with suitable series resistance to provide a remote load current indication.

CIRCUIT DESCRIPTION

Basic principle

The function of the pre-regulator is to minimise the power dissipation in the series regulator by keeping the voltage across it constant under all output and input conditions.

Output current is monitored by the voltage across the current sensing resistor, and this signal is fed to the constant current amplifier. Any change in output current is detected, amplified and fed to the series regulator in such a sense as to oppose the original change.

Similarly, output voltage is sensed by the constant voltage amplifier and any change is amplified and fed to the series regulator in such a sense as to oppose the original change.

S.C.R. control

The control circuit consists of a pulse output stage feeding the S.C.R.s, which is driven by a high frequency oscillator which in turn is gated by a pulse width modulated signal from a comparator. This compares the signal from a further comparator with a ramp waveform which is synchronised to twice the supply frequency. The second comparator compares the separation voltage with an internal reference voltage.

A zero threshold switch R7, R8 and VT1 switches on VT2 every half cycle. C5 is charged via R13 until VT2 conducts and discharges C5, thus a ramp waveform of approx. 5V peak to peak appears across C5 synchronised to twice the supply frequency.

VT3, R23, R26 and Z6 form a constant current source feeding the reference zener Z5, this feeds the potential divider R6, P1 and R3. Half of IC1 compares the voltage at the junction of P1 and R3 with zero line via R5 and provides a proportional change in output at the cathode of D5. R1, R2, C1 and C2 form a compensating network for stability against a.c. ripple at the sensing point.

R11 and P2 form a d.c. potential divider providing a variable voltage at D9 which catches the control voltage from D5. The second comparator, which compares this voltage with the ramp waveform across C5, provides a variable mark/space ratio output signal at R17. P2 sets an upper voltage limit on the signal into the second comparator and this acts as a minimum mark limit. The output at R17 is limited at 5V by Z4 and fed to pin 1 of IC2 as an inhibit signal.

IC2 is a dual quad input nand Schmitt whose output at pin 6 is fed back via R18, R19 and D6 to an input at pin 2 and with C7 forms an oscillator at approx. 10kHz. The variable mark/space signal at pin 1 stops the oscillations during the space and therefore a burst of 10kHz square wave appears during the variable on time or mark. The remaining two inputs at pins 4 and 5 can inhibit the oscillator and thus switch the S.C.R.s off.

The output at pin 6 is inverted through the second gate (input at pin 9 and output pin 8) and fed via R21 to a further inverter

stage VT4. This drives VT5 via R25 and R24 and subsequently fires the S.C.R. gates via the pulse transformer T1.

The bridge rectifier MR1 is fed from the 6.5V winding on MT2, smoothed by C9 and is used as an auxiliary driver supply for VT1 on the driver assembly on the H30/100 only.

Auxiliary supply H30/100

Supplies for the control amplifier circuit board are derived from a 36-0-36 volt winding on MT2. This is rectified by diodes D1 and D2 and smoothed by capacitors C1 and C2. VT1, VT2, VT3, Z1 and associated resistors form a constant current source feeding zener diodes Z2 and Z3 giving a +15V-0--15V supply for the control amplifiers.

This circuit board also incorporates two thermal trip circuits, to monitor the regulator and rectifier heatsink assembly temperatures and shut down the supply if a dangerous temperature is reached. A warning lamp and reset button are provided on the front panel.

The dual OP-AMP IC1 is connected as two Schmitt triggers which sense between the zero line and the potential divider P3, R16, R15 and TH1. TH1 is connected between pins 17 and 13 and mounted on regulator heatsink assembly. TH2 connected between pins 16 and 11 is mounted on the rectifier heatsink assembly. The outputs of the two Schmitt triggers are summed at the base of VT4 and therefore VT4 turns on when a dangerous temperature is reached on either heatsink assembly. This causes SCR1 to conduct, lighting the warning lamp and feeding a shutdown signal via pin 7 to the control amplifiers. After the heatsink has cooled sufficiently to allow the Schmitt to reset, the unit may be reset by pressing and releasing the reset button connected between pins 5 and 7.

P1, R1 and P2, R2 are meter calibration resistors.

Auxiliary supply H60/50 & H60/25

Supplies for the control amplifier circuit board are derived from a 36-0-36 volt winding on MT2. This is rectified by diodes D11 and D12 and smoothed by capacitors C7 and C8. VT9, VT10, VT11, Z4 and associated resistors form a compound current source feeding zener diodes Z5 and Z6 giving a +15-0--15 volt supply for the control amplifiers.

Also on this circuit board is the thermal overload circuitry. This senses the regulator heatsink temperature via the thermistor mounted on the heatsink assembly and shuts down the supply if a dargerous temperature is reached. A warning lamp and reset button are provided and are situated in the centre of the front panel.

VT28 and VT29 form a Schmitt trigger which senses between the zero line and potential divider P6, R37, TH1 and R36 (TH1 being connected between pins 1 and 6). Normally VT28 is non-conducting but if a dangerous temperature is sensed then the Schmitt trigger

changes state and VT28 conducts. This causes SCR1 to conduct lighting the warning lamp and feeding a shutdown signal via pin 12 to the control amplifier. After the heatsink has cooled sufficiently to allow the Schmitt trigger to reset by pressing and releasing the reset button connected between pins 11 and 14.

P5, R80 and P12, R79 are meter calibration resistors.

Control amplifiers

These consist of the following:- (a) Voltage reference and constant voltage amplifier (b) Current reference and constant current amplifier (c) Shutdown and short circuit protection amplifier (D) Drive circuit.

(a) Voltage reference and C.V. amplifier

VT1, Z1, R1 and R3 comprise a constant current source feeding the reference zener Z2 and potential divider R4 and front panel potentiometers, P1 and P2. IC1 compares the voltage at the junction of R5 and P1 with the zero line, and produces an output change proportional to the original output voltage change. P3 is provided to offset the output of the comparator to obtain zero voltage output.

(b) Current reference and C.I. amplifier

VT5, Z4, R25 and R26 comprise a constant current source feeding the reference zener Z3 and potential divider R27, P2 and front panel potentiometers P3 and P4. IC2 compares the voltage at the junction of P2 and P3 with the voltage across the current sense resistor. Any change in output current causes a change in voltage across the sense resistor and the comparator produces an output change proportional to the original current change. P4 is provided to offset the output of the comparator to obtain zero current output.

(c) Shutdown and short circuit protection amplifier

This consists of IC3, VT3, VT4 and associated resistors. Pin 17 is connected to the unregulated d.c. line, pin 7 is connected to the anode of SCR1 in the thermal overload circuit, and pin 9 is connected to the positive end of the current sense resistor.

The output of IC3 at D4 is normally in such a condition as to not effect the operation of the C.V. and C.I. amplifiers at D3 and D5. If the separation voltage (i.e. across pins 13 and pin 17) exceeds approx. 20 volts, VT4 and VT3 cease to conduct and IC3 begins to reduce the output. As the separation voltage increases further the output current is reduced linearly to approx. 2A when the separation voltage reaches approx. 60 volts. This prevents 'second breakdown' failure of the series regulator transistors on applying a sudden short circuit to the unit output terminals.

If a thermal overload is detected, SCR1 (on the auxiliary supplies board) conducts and connects pin 7 to the -15V auxiliary line. This forward biases D6 and causes IC3 to feed a shutdown signal via D4, and no output can flow until the unit is reset.

(d) Drive circuit

The outputs of IC1, IC2 and IC3 are commoned through D3, D4 and D5 at the base of the emitter follower VT2, and the signal from its emitter is fed via pin 6 to the series regulator.

Series regulator H30/100

This consists of transistors VT1 to VT19. VT4 to VT19 are connected in two parallel banks of eight, each fed from the second emitter followers VT2 and VT3. The drive to VT2 and VT3 is commoned from the output at the emitter of VT1 which in turn is driven from pin 6 of the control amplifier board. VT1 in the series regulator circuit and VT2 on the control board are both supplied from a further low voltage auxiliary line from pins 1 and 2 of the SCR control board.

Series regulator H60/50

This consists of transistors VT30 to VT39, VT30 and VT31 being cascaded emitter followers driving the parallel connected emitter followers VT32 to VT39.

Series regulator H60/25

This consists of transistors VT30 to VT35, VT30 and VT31 being cascaded emitter followers driving the parallel connected emitter followers VT32 to VT35.

MAINTENANCE

The equipment supplied by Farnell Instruments Ltd., is guaranteed against defective material and faulty manufacture for a period of twelve months from the date of despatch. In the case of material or components employed in the equipment but not manufactured by us, we allow the customer the period of any guarantee extended to us.

The equipment has been carefully inspected and submitted to comprehensive tests at the factory prior to despatch. If, within the guarantee period, any defect is discovered in the equipment in respect of material or workmanship and reasonably within our control, we undertake to make good the defect at our own expense subject to our standard conditions of sale. In exceptional circumstances and at the discretion of the Service Manager, a charge for labour and carriage costs incurred may be made.

Our responsibility is in all cases limited to the cost of making good the defect in the equipment itself. The guarantee does not extend to third parties, nor does it apply to defects caused by abnormal conditions of working, accident, misuse, neglect or wear and tear.

In the event of difficulty, or apparent circuit malfunction, it is advisable to telephone (or telex) the Service Department or your local Sales Engineer or Agent (if overseas) for advice before attempting repairs.

For repairs it is recommended that the complete unit be returned to:-

The Service Department,
Farnell Instruments Ltd.,
Sandbeck Way,
Wetherby, Yorkshire.
LS22 4DH

Tel: 0937 3541 Telex: 557294

or

Service Depot,
Farnell Instruments Ltd.,
Hermitage Road,
London N.4.

Tel: 01-802 5359

Please ensure adequate care is taken with packing and arrange insurance cover against transit damage or loss.

For those who operate their own comprehensive service department a section on 'Internal Adjustments' will be found on page 14.

INTERNAL ADJUSTMENTS

Mains input

Units are for operation at 240 volts input only. Special units can be manufactured for mains inputs of 220, 380 or 415V 50/60Hz.

WARNING

No attempt should be made to make any adjustments without strict reference to the following instructions, otherwise damage may result.

Meter calibration

(1) Voltmeter: With the unit giving 30 volts output on H30/100 or 60V on H60/50 or H60/25 (measured using an accurate external meter) adjust P2 on H30/100 or P12 on H60/50 or H60/25 (on the auxiliary supplies circuit board) until the front panel meter reads full scale.

(2) Ammeter: With the unit giving full output current (measured using an accurate external meter) adjust P1 on H30/100, or P5 on H60/50 or H60/25 (on the auxiliary supplies circuit board) until the front panel meter reads full scale.

Maximum output voltage

(1) With both 'VOLTAGE ADJUST' controls turned fully anticlockwise, adjust P3 (on the control amplifiers circuit board) until a positive output of less than 50mV is measured on an external meter.

(2) With both 'VOLTAGE ADJUST' controls turned fully clockwise, adjust P1 until an output of 30.5 volts on H30/100 or 60.5V on 60V models is measured using an external meter.

Maximum output current

(1) With both 'CURRENT ADJUST' controls turned fully anticlockwise, adjust P4 until a positive output current of less than 50mA is measured on an external meter.

(2) With both 'CURRENT ADJUST' controls turned fully clockwise, adjust P2 until a current of 101 amps on H30/100 or 50.5A or 25.25A on the 50A and 25A models is measured on an external meter.

Thermal overload (H30/100)

With the unit running at 100 amps output and thermocouple type thermometer probes attached to the regulator heatsink and rectifier heatsink (with top and bottom covers in place) block the air inlet and outlet vents. The warning lamp should light and the unit should shutdown when a temperature of approx. 100°C is measured on the rectifiers and 110°C on the regulators. If this is not so, adjust P3 and P4 on the auxiliary supplies board and repeat the operation after allowing 3-4 minutes off load running for cooling.

Thermal overload H60/50 & H60/25

With the unit running at full load current and a thermocouple type thermometer probe attached to the top regulator heatsink near the inlet fan (with top and bottom covers in place) block the air inlet and outlet vents. The warning lamp should light and the unit shutdown when a temperature of approximately 100°C is measured. If this is not so, adjust P6 on the auxiliary supplies board and repeat the operation after allowing 3-4 minutes off load running for cooling.

N.B. Should any further adjustments appear to be necessary all the following instructions should be carried out in the set sequence.

Separation voltage

With the unit output terminals short circuited, turn the output current up from zero to full load. Connect a voltmeter across the reservoir capacitors and adjust P1 on SCR control board, to give 6.0 volts on the H30/100 model and 8.5V on the H60/50 and H60/25 models.

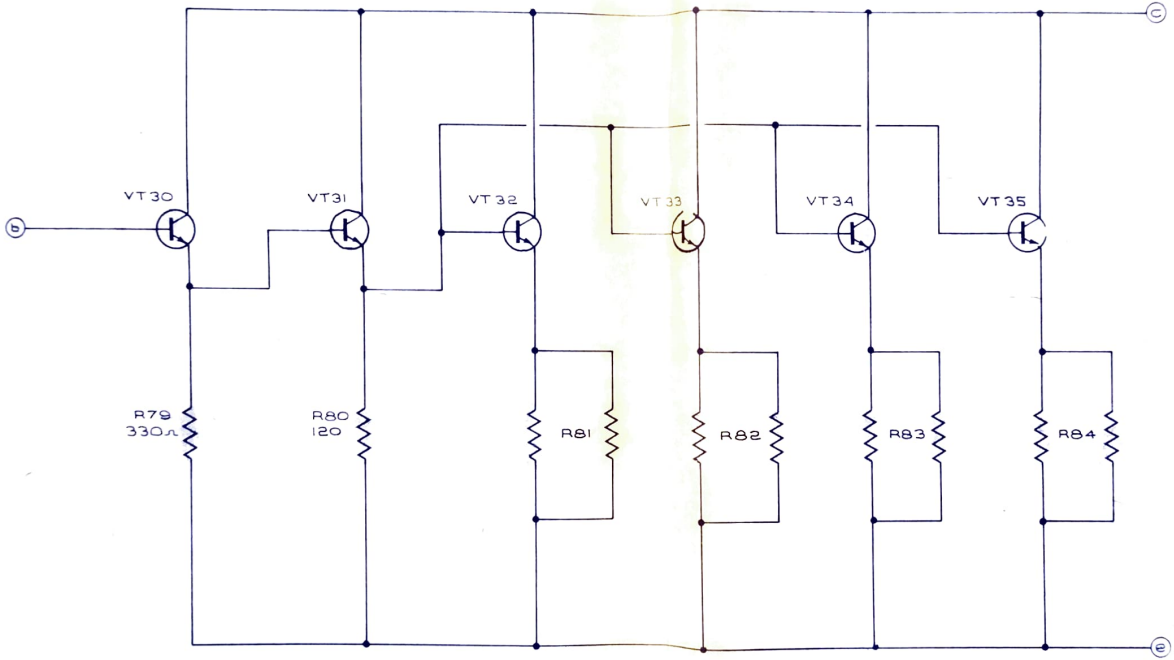
Short circuit protection

Disconnect the lead from pin 17 on the control amplifiers circuit board at its connection to the driver transistor. With the output terminals short circuited adjust the output current from zero to full load. Connect a 0-60 volt variable d.c. power supply (current is less than 5mA) between the positive output terminal and the disconnected wire. Slowly increase the voltage from the variable supply. At approximately 20 volts, output current should start to fall. Adjust P5 on the control amplifier circuit board so that the change in current is smooth and not a sudden step when varying the voltage about this point. Increase the voltage to 60 volts and adjust P6 to give an output current of less than 2 amp. Repeat the operation until no further improvement can be made. Remove the variable supply and reconnect the lead from pin 17.

N.B. All trimmers should be locked with a suitable compound after adjustment.

DRG No 3-6530

R		79		80		81		82		83		84
C												
VT		30		31		32		33		34		35
MISC												



NOTE ALL TRANSISTORS TYPE 2N3055
RESISTORS R81 TO R84 2OF 0·5Ω W22

TRACED												
CHECKED												
DRAWN	PMR	ISS.	DATE	MOD. No.								
		1	30-6-71	—								

NOTE —
CAPACITOR VALUES GIVEN IN μF
RESISTOR VALUES IN Ω
(1) REFERS TO CCT. BD. PIN CONNECTION Nos.

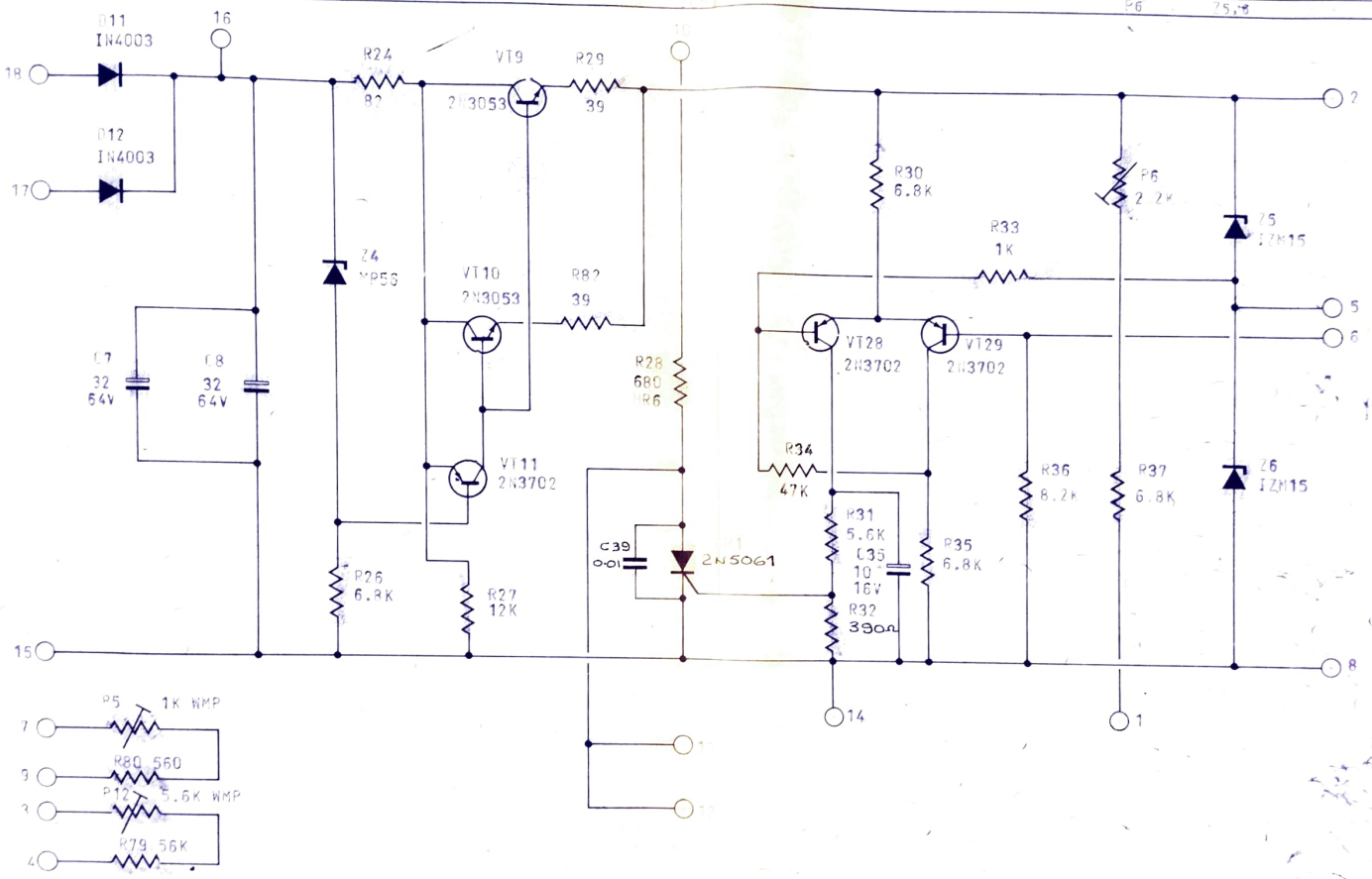
FARNELL INSTRUMENTS LTD. WETHERBY YORKS.

SERIES REGULATOR DIAGRAM H60/25

DRAWING No. 3-6530

R	80, 79		26, 24		27		82,	29, 28		31, 32, 30, 35		33	36	37
C		7	8					39		35				
VT						11, 10, 9								
MISC	P5, 12	D11, 12			24					28,	29			

DRG No 3-5566



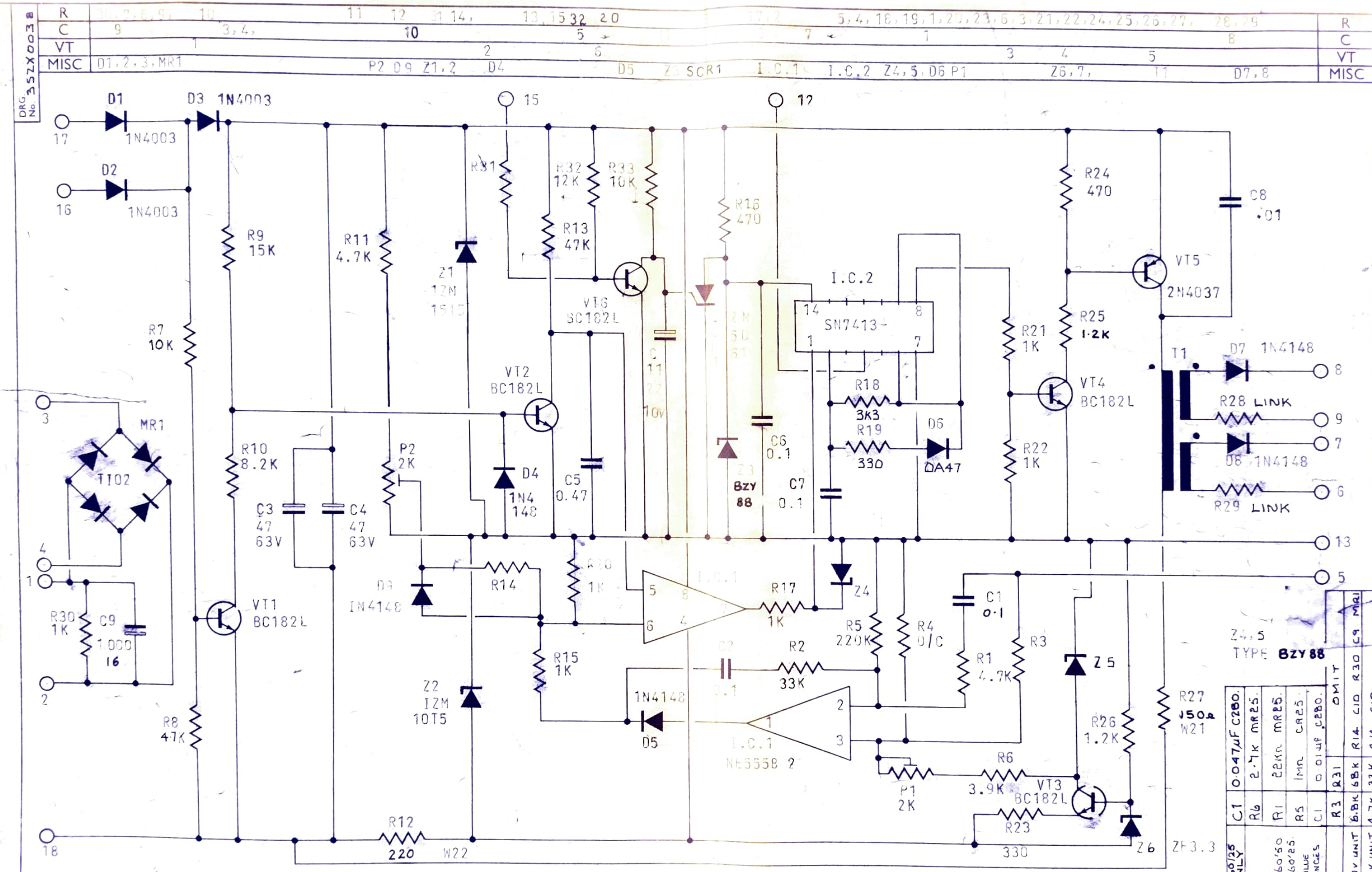
TRACED		5	21.4.71	Q829	6	21.10.71	Q1104			
CHECKED		4	16.2.71	Q721						
		3	3.2.71	853						
DRAWN	D.W.	2	9.12.70	826						
		ISS.	DATE	MOD. No.						
		1	2.11.70	~						

NOTE —
CAPACITOR VALUES GIVEN IN μF.
RESISTOR VALUES IN Ω
② REFERS TO CCT. BD. PIN CONNECTION Nos

FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

AUXILIARY SUPPLIES. CIRCUIT DIAGRAM. H60/50 AND H60/25

DRAWING No. 3-5566



DRG. No. 35ZX0038
R
C
VT
MISC
D1 1N4003
D2 1N4003
D3 1N4003
17
16
15
12
3
4
1
2
18
13
5
8
9
7
6
MR1
TI02
R30 1K
C9 1,000 16
VT1 BC182L
R8 47K
R7 10K
R9 15K
R10 8.2K
R11 4.7K
C3 47 63V
C4 47 63V
P2 2K
Z1 1ZM 15T5
VT2 BC182L
D4 1N4 148
D9 1N4148
R14
Z2 1ZM 10T5
R31
R32 12K
R33 10K
R13 47K
VT6 BC182L
C5 0.47
R20 1K
R15 1K
D5 1N4148
R16 470
C6 0.1
Z3 BZY 88
C7 0.1
I.C.2 SN7413
R18 3K3
R19 330
D6 OA47
R17 1K
Z4
I.C.1 NE5558
C2 0.1
R2 33K
R5 220K
R4 O/C
C1 0.1
R1 4.7K
R3
P1 2K
R6 3.9K
VT3 BC182L
R23 330
R12 220 W22
Z5
R26 1.2K
Z6 ZF3.3
R27 150Ω W21
R21 1K
R22 1K
VT4 BC182L
R24 470
R25 1.2K
VT5 2N4037
C8 .01
T1
D7 1N4148
D8 1N4148
R28 LINK
R29 LINK
Z4,5 TYPE BZY88

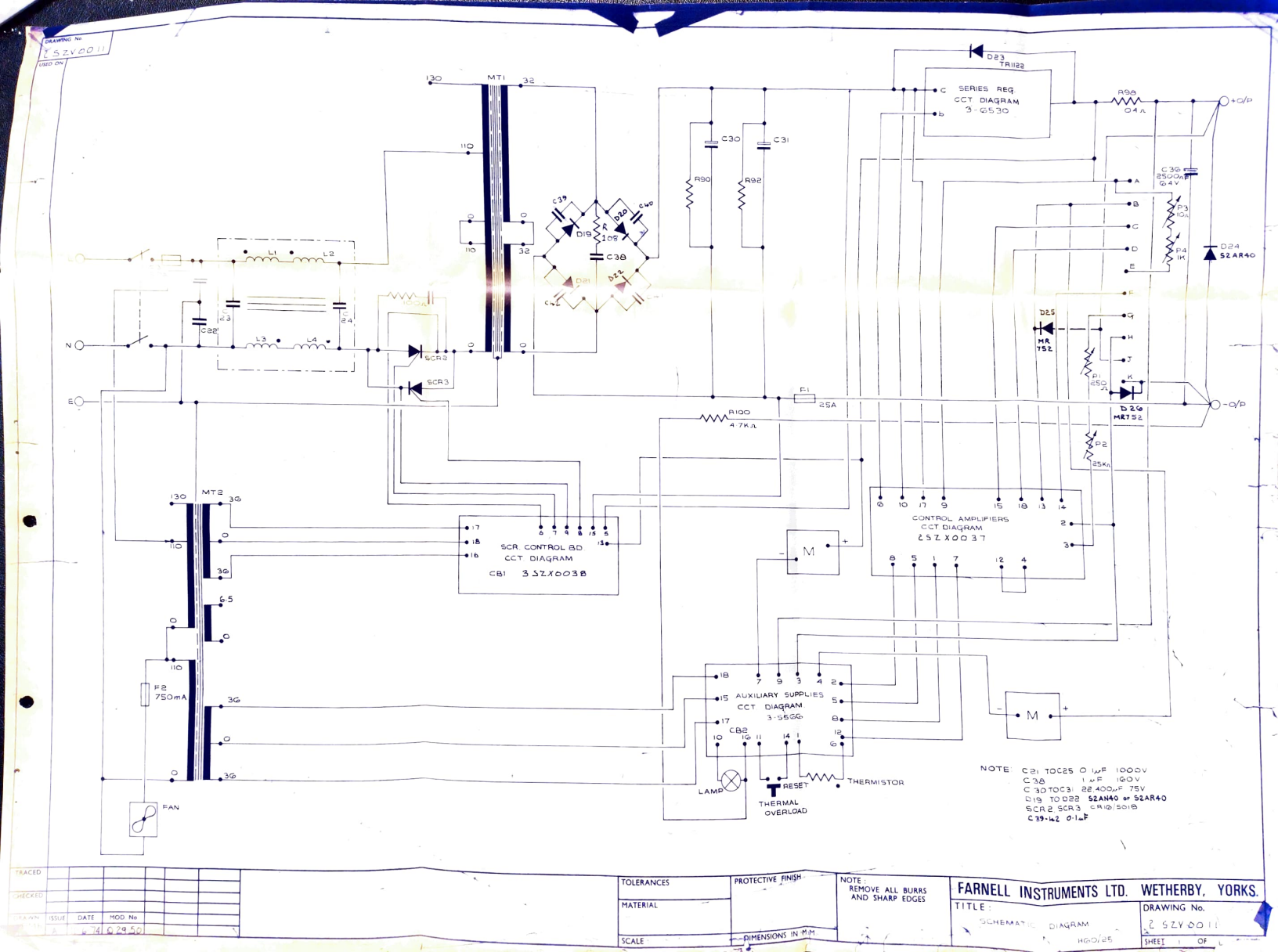
TRACED		E	13-10-75	Q3596.	F.	8-3-76	Q3787.
CHECKED	P. Ca.	D	9-6-75	Q3409	G	30-3-76	Q3797
		C	15.1.75	Q3320	H	17-8-76	Q3937
		B	12.12.74	Q3278	I	28-9-76	Q4010
DRAWN	M.H.	ISS:	DATE	MOD. No.	J	23-11-76	Q4074
		A	26-9-73		K	13.9.77	Q4346

NOTE :—
CAPACITOR VALUES GIVEN IN μF.
RESISTOR VALUES IN Ω
(2) REFERS TO CCT. BD. PIN CONNECTION Nos.

FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

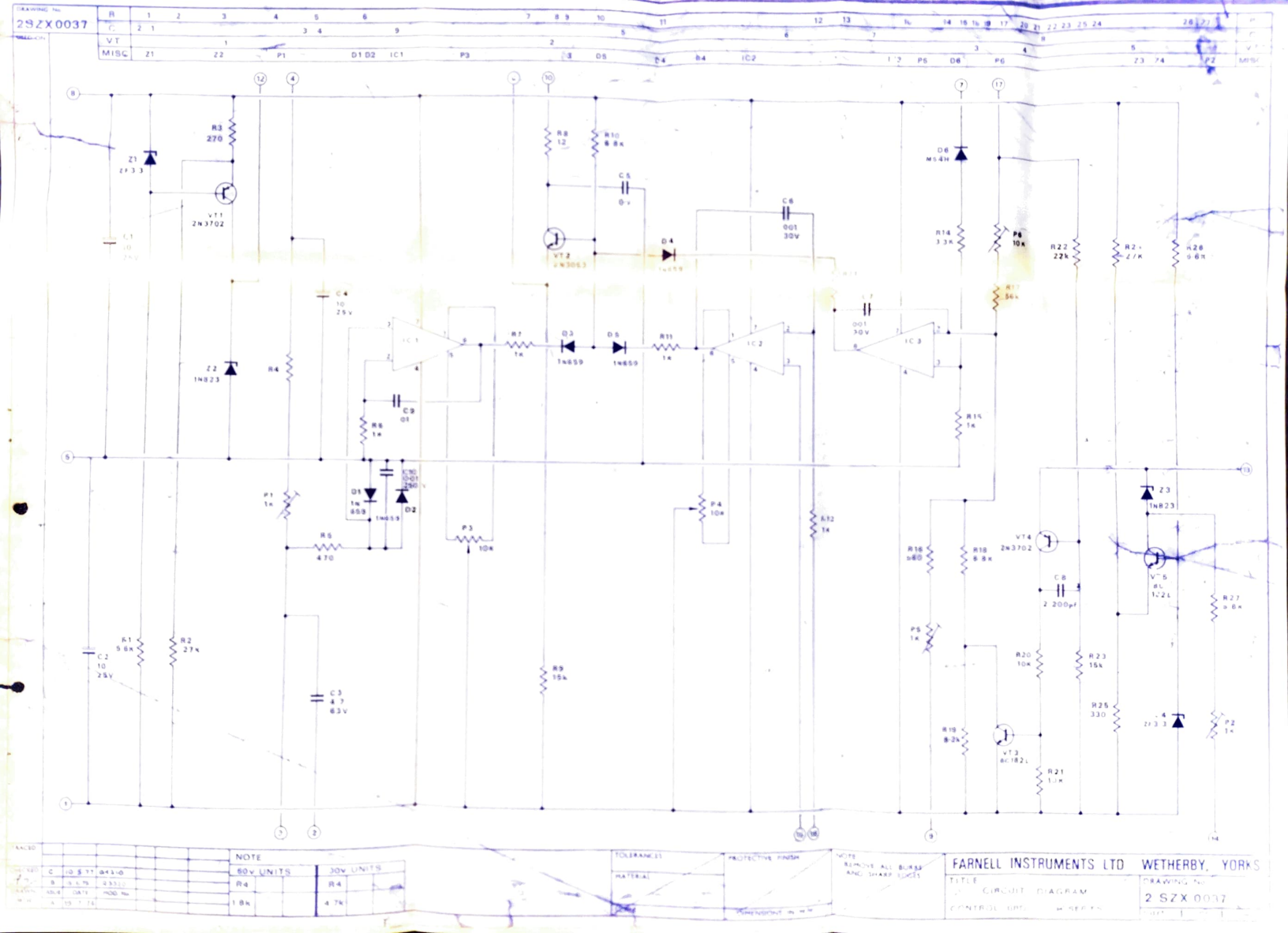
SCR. CONTROL CIRCUIT BOARD
CIRCUIT DIAGRAM.

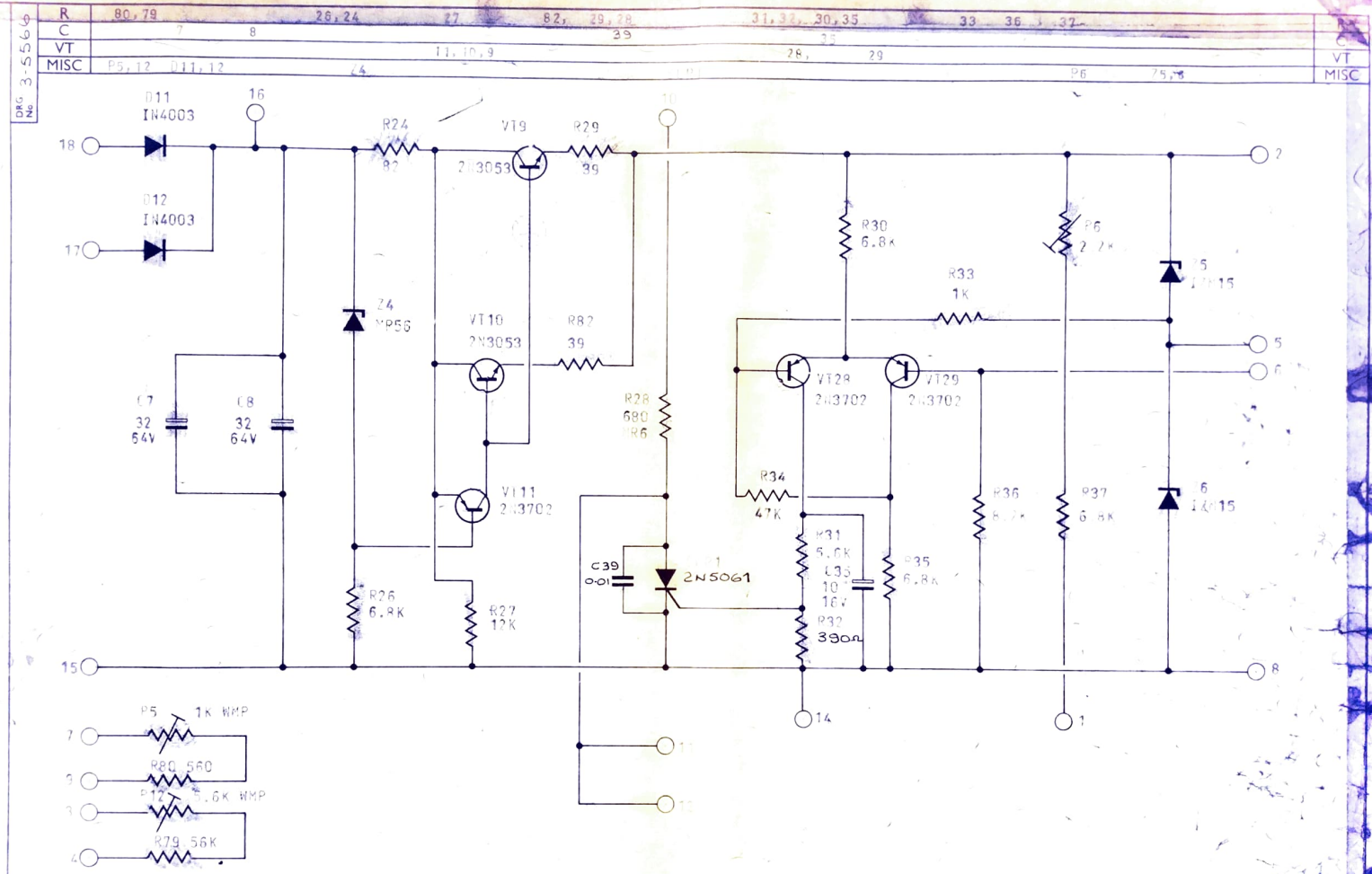
DRAWING No. 35ZX0038



NOTE: C21 TO C25 0.1μF 1000V
C38 1μF 160V
C30 TO C33 22,400μF 75V
D19 TO D22 S2AN40 or S2AR40
SCR2 SCR3 CR16/5018
C39-42 0.1μF

TRACED				TOLERANCES	PROTECTIVE FINISH	NOTE: REMOVE ALL BURRS AND SHARP EDGES	FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.	
CHECKED				MATERIAL			TITLE: SCHEMATIC DIAGRAM	DRAWING No. 3 SZX0011
DRAWN	ISSUE	DATE	MOD No	SCALE	DIMENSIONS IN MM		IGO/25	SHEET 1 OF 1
	A	6.7.1	29.50					


DRAWING No. 2SZX0037
Z1 ZF3.3
R3 270
VT1 2N3702
C1 10 25V
Z2 1N823
R4
C4 10 25V
IC1
R7 1k
D3 1N659
D5 1N659
R11 1k
IC2
IC3
C7 001 30V
R17 56k
R8 12
R10 8.8k
C5 0·1
VT2 2N3063
D4 1N659
C6 001 30V
D6 MS4H
R14 3.3k
P6 10k
R22 22k
R24 2·7K
R26 9·6k
R15 1k
C9 01
R6 1k
D1 1N659
D2 1N659
C10 0·01 250V
P1 1k
R5 470
P3 10k
P4 10k
R12 1k
R16 560
R18 6·8k
VT4 2N3702
C8 2 200pF
P5 1k
R20 10k
R23 15k
R25 330
R19 8·2k
VT3 BC182L
R21 1·1k
Z3 1N823
VT5 BC 182L
R27 6·8k
Z4 ZF3.3
P2 1k
C2 10 25V
R1 5·6k
R2 27k
C3 4·7 63V
R9 15k
NOTE
50V UNITS
R4
1·8k
30V UNITS
R4
4·7k
TOLERANCES
MATERIAL
PROTECTIVE FINISH
REMOVE ALL BURRS AND SHARP EDGES
FARNELL INSTRUMENTS LTD WETHERBY, YORKS
TITLE
CIRCUIT DIAGRAM
CONTROL UNIT
DRAWING No.
2 SZX 0037



TRACED		5	21.4.71	Q829	6	21.10.71	Q1104		
CHECKED		4	16.2.71	Q721					
		3	3.2.71	853					
DRAWN	D.W.	2	9.12.70	826					
		ISS.	DATE	MOD. No.					
		1	2.11.70	~					

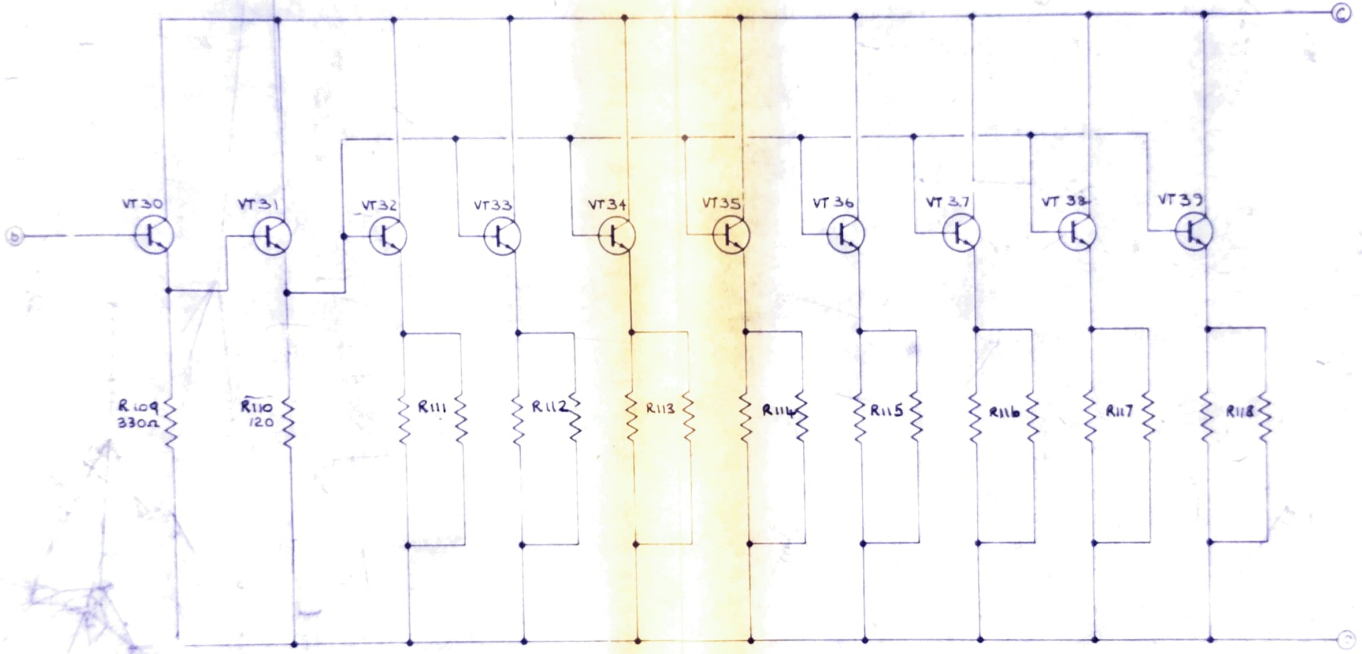
NOTE :—
CAPACITOR VALUES GIVEN IN μF
RESISTOR VALUES IN Ω
② REFERS TO CCT. BD. PIN CONNECTION Nos.

FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

AUXILIARY CIRCUITS CIRCUIT DIAGRAM. H60/50 AND H60/25

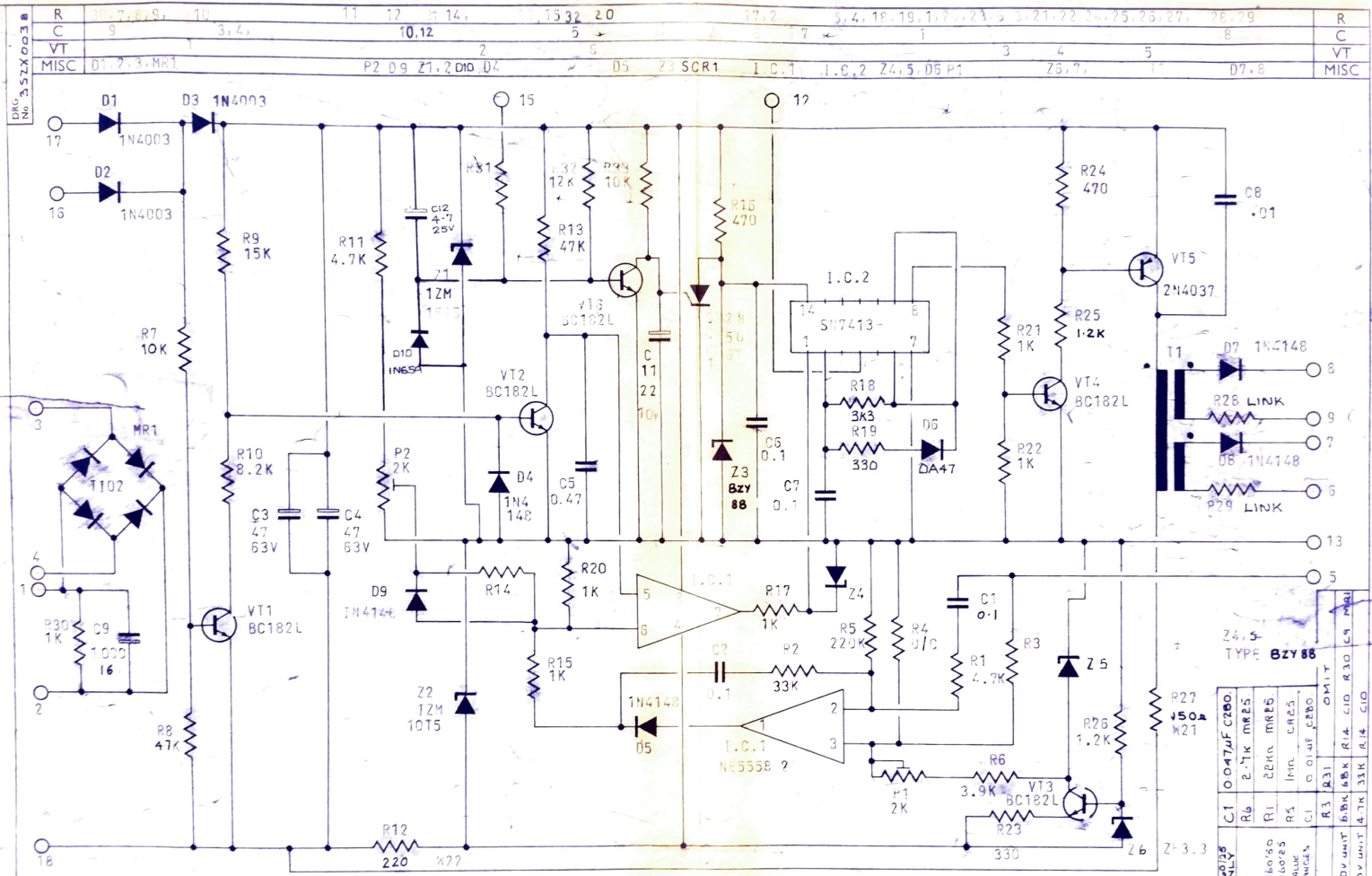
DRAWING No. 3-556/2

	109	110	111	112	113	114	115	116	117	118
R										
C										
VT	30	31	32	33	34	35	36	37	38	39
MISC										



NOTE ALL TRANSISTORS TYPE 2N3055
RESISTORS R111 TO R118 2OFF 0.5Ω W22

TRACED		NOTE	FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.
CHECKED		CAPACITOR VALUES GIVEN IN μF RESISTOR VALUES IN Ω (2) REFERS TO CCT. BD. PIN CONNECTION Nos	SERIES REGULATOR DIAGRAM H60/50
DRAWN O W	2 1-8-72 G1573 ISS DATE MOD. No. 1 1-11-70		DRAWING No 3-5568



TRACED		E	13-10-75	Q3596	F	8-3-76	Q3787	L	13.6.78	Q4700
CHECKED		D	9-6-75	Q3409	G	30-3-76	Q3797			
		C	15.1.75	Q3320	H	17-8-76	Q3937			
DRAWN	R.H.	B	12.12.74	Q3278	I	28-9-76	Q4010			
		ISS	DATE	MOD No	J	23.11.76	Q4074			
					K	18.9.77	Q4396			

NOTE —
CAPACITOR VALUES GIVEN IN μF
RESISTOR VALUES IN Ω
(2) REFERS TO CCT. BD. PIN CONNECTION Nos.

FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

SCR CONTROL CIRCUIT BOARD
CIRCUIT DIAGRAM.

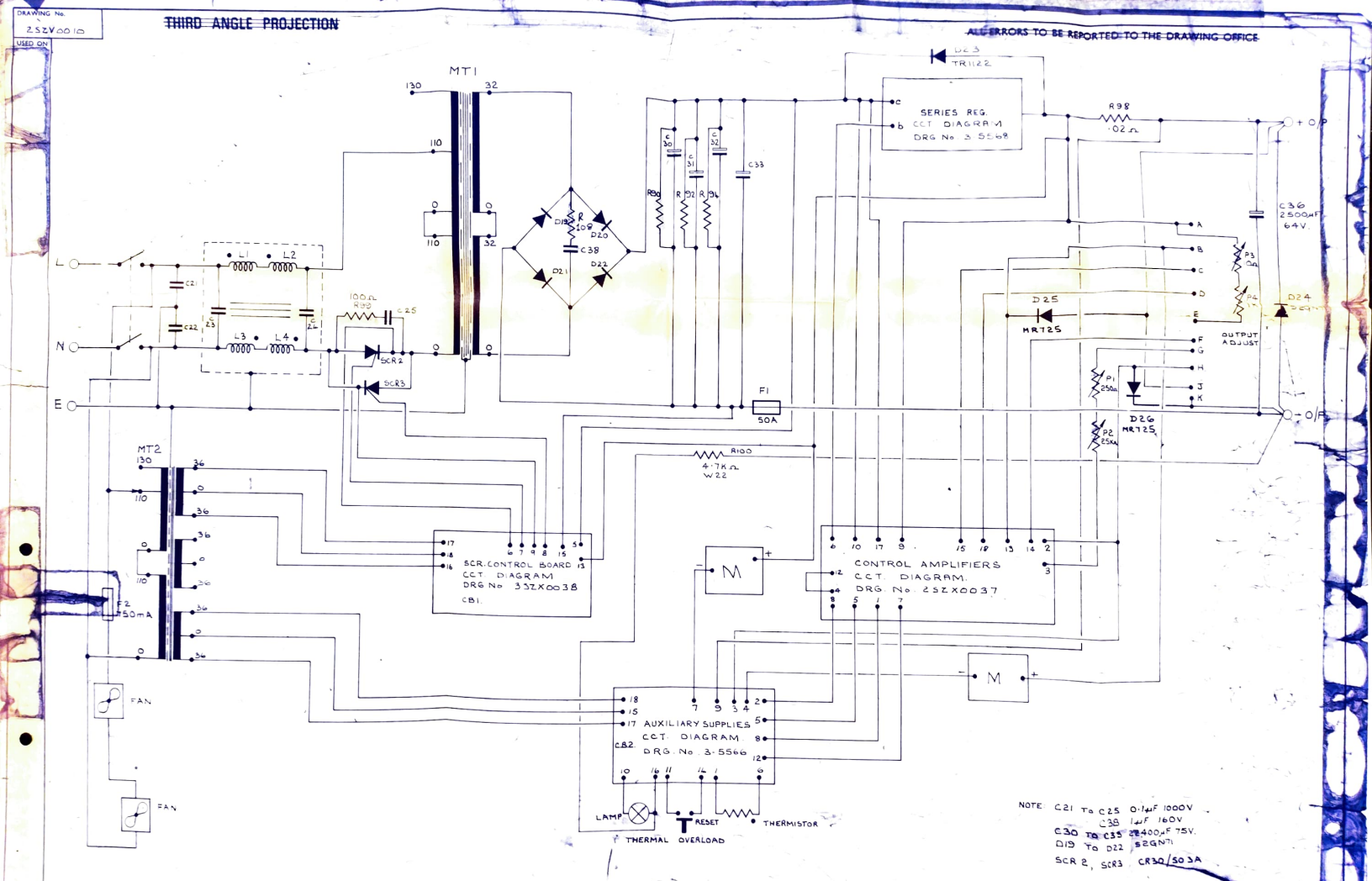
DRAWING No.
35ZX0038

DRAWING No. 2 SZV 0010

USED ON

THIRD ANGLE PROJECTION

ALL ERRORS TO BE REPORTED TO THE DRAWING OFFICE



NOTE: C21 To C25 0·1μF 1000V
C38 1μF 160V
C30 To C35 22400μF 75V.
D19 To D22 / S2GN71
SCR 2, SCR3 CR30/503A

TRACED						
CHECKED						
DRAWN	ISSUE	DATE	MOD No			
[illegible]	A	[illegible]	02960			

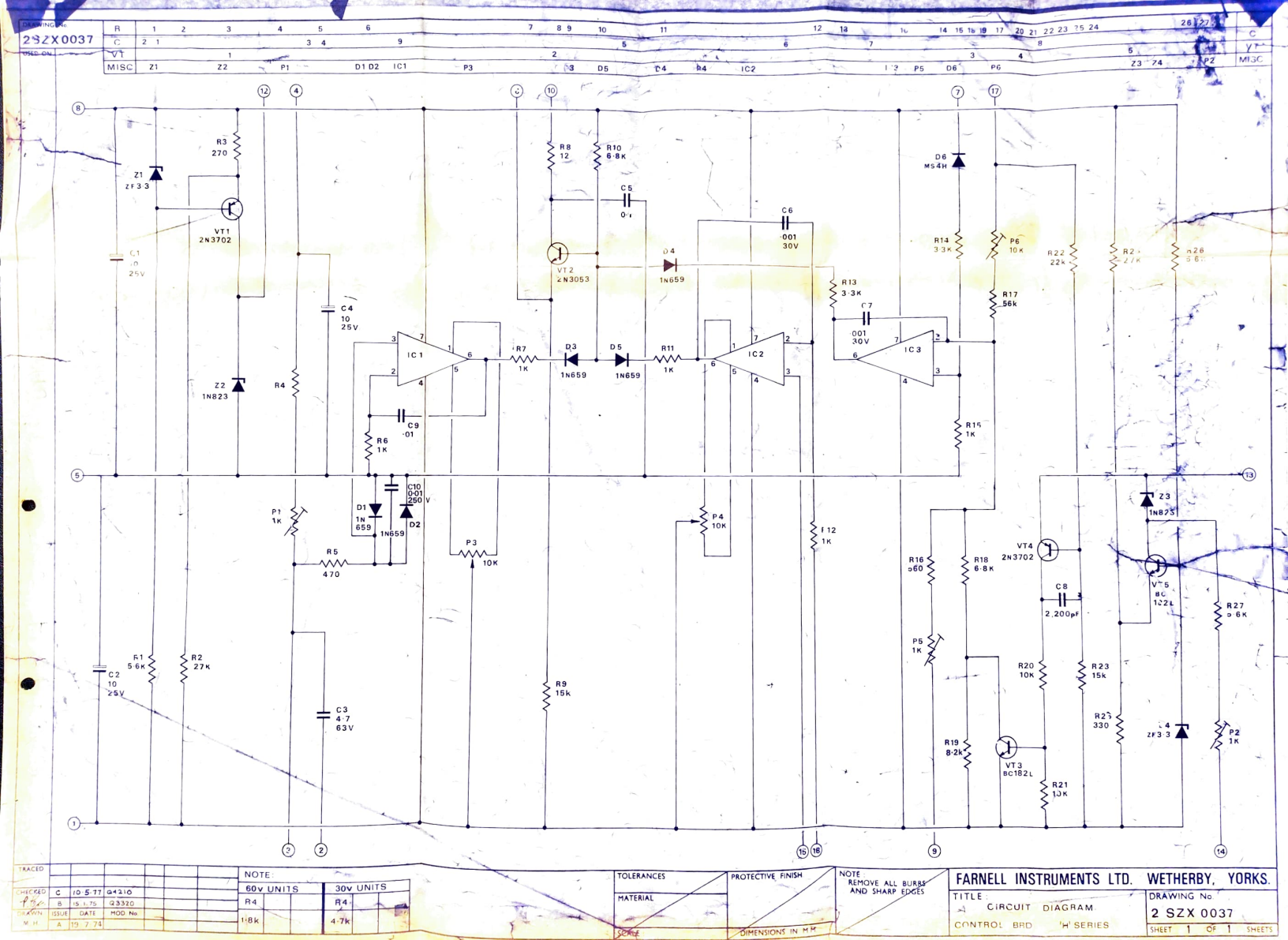
TOLERANCES	PROTECTIVE FINISH	NOTE: REMOVE ALL BURRS AND SHARP EDGES
MATERIAL		
SCALE	DIMENSIONS IN M.M	

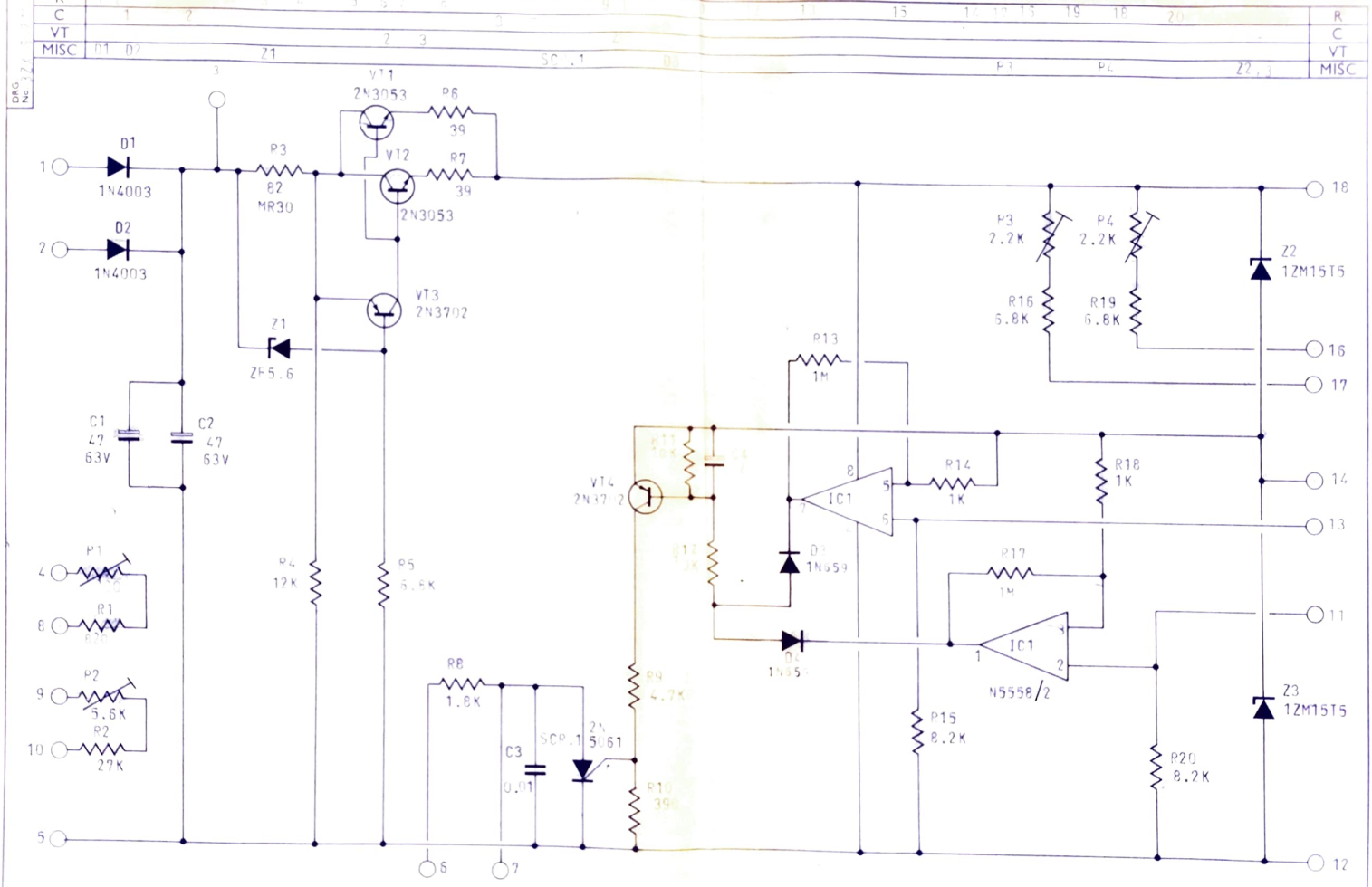
FARNELL INSTRUMENTS LTD. WETHERBY, YORKS

TITLE: SCHEMATIC DIAGRAM H60

DRAWING No. 2 SZV0010

SHEET OF

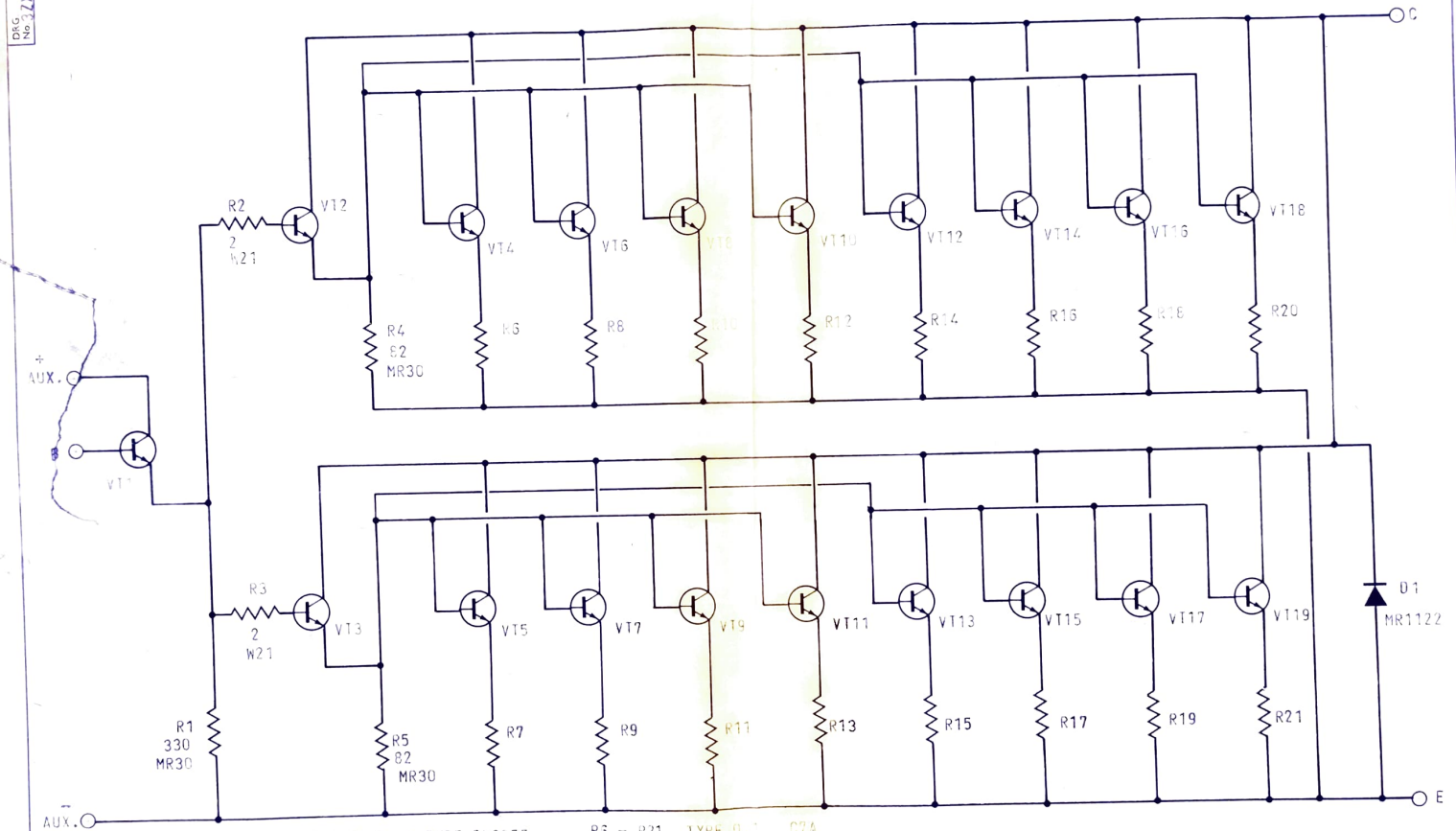

DRAWING No. 2SZX0037
USED ON
R3 270
Z1 ZF3.3
VT1 2N3702
C1 10 25V
Z2 1N823
R4
C4 10 25V
R6 1K
C9 ·01
IC1
R7 1K
D3 1N659
D5 1N659
R11 1K
R8 12
R10 6·8K
C5 ·01
VT2 2N3053
D4 1N659
C6 ·001 30V
IC2
R13 3·3K
C7 ·001 30V
IC3
D6 MS4H
R14 3·3K
P6 10K
R22 22K
R17 56K
R15 1K
P1 1K
D1 1N659
D2 1N659
C10 0·01 250V
R5 470
P3 10K
P4 10K
R12 1K
Z3 1N823
VT4 2N3702
VT5 BC182L
C8 2,200pF
R16 560
R18 6·8K
R27 5·6K
P5 1K
R20 10K
R23 15K
R25 330
R19 8·2K
VT3 BC182L
R21 10K
Z4 ZF3.3
P2 1K
C2 10 25V
R1 5·6K
R2 27K
C3 4·7 63V
R9 15K
TRACED
CHECKED
DRAWN
C 10·5·77 Q4210
B 15.1.75 Q3320
A 19.7.74 MOD No.
ISSUE DATE
M.H
NOTE:
60v UNITS
R4 18k
30v UNITS
R4 4·7k
TOLERANCES
MATERIAL
PROTECTIVE FINISH
SCALE
DIMENSIONS IN M/M
NOTE REMOVE ALL BURRS AND SHARP EDGES
FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.
TITLE CIRCUIT DIAGRAM CONTROL BRD 'H' SERIES
DRAWING No. 2 SZX 0037
SHEET 1 OF 1 SHEETS



TRACED				NOTE — CAPACITOR VALUES GIVEN IN µF RESISTOR VALUES IN Ω ② REFERS TO CCT. BD. PIN CONNECTION Nos	FARNELL INSTRUMENTS LTD. WETHERBY, YORKS
CHECKED	P.C.	B	1-4-74		
DRAWN	M.H.	ISS	DATE MOD No		AUX. SUPPLIES CIRCUIT DIAGRAM U30/100
		A	12-11-74		DRAWING No 3 ZX 0542 1/3

R		2	3	4,5,	6,7,	8,9,	10,11			14,15,	16,17		18,19, 20,21						C
C																			VT
VT	1	2,3,		4,5,	6,7,	8,9,	10,11	12,13,		14,15,		16,17		18,19,					MISC
MISC																			

DSG No. 3 ZX 0642 105



ALL TRANSISTORS TYPE 2N3055 R6 – R21 TYPE [illegible]

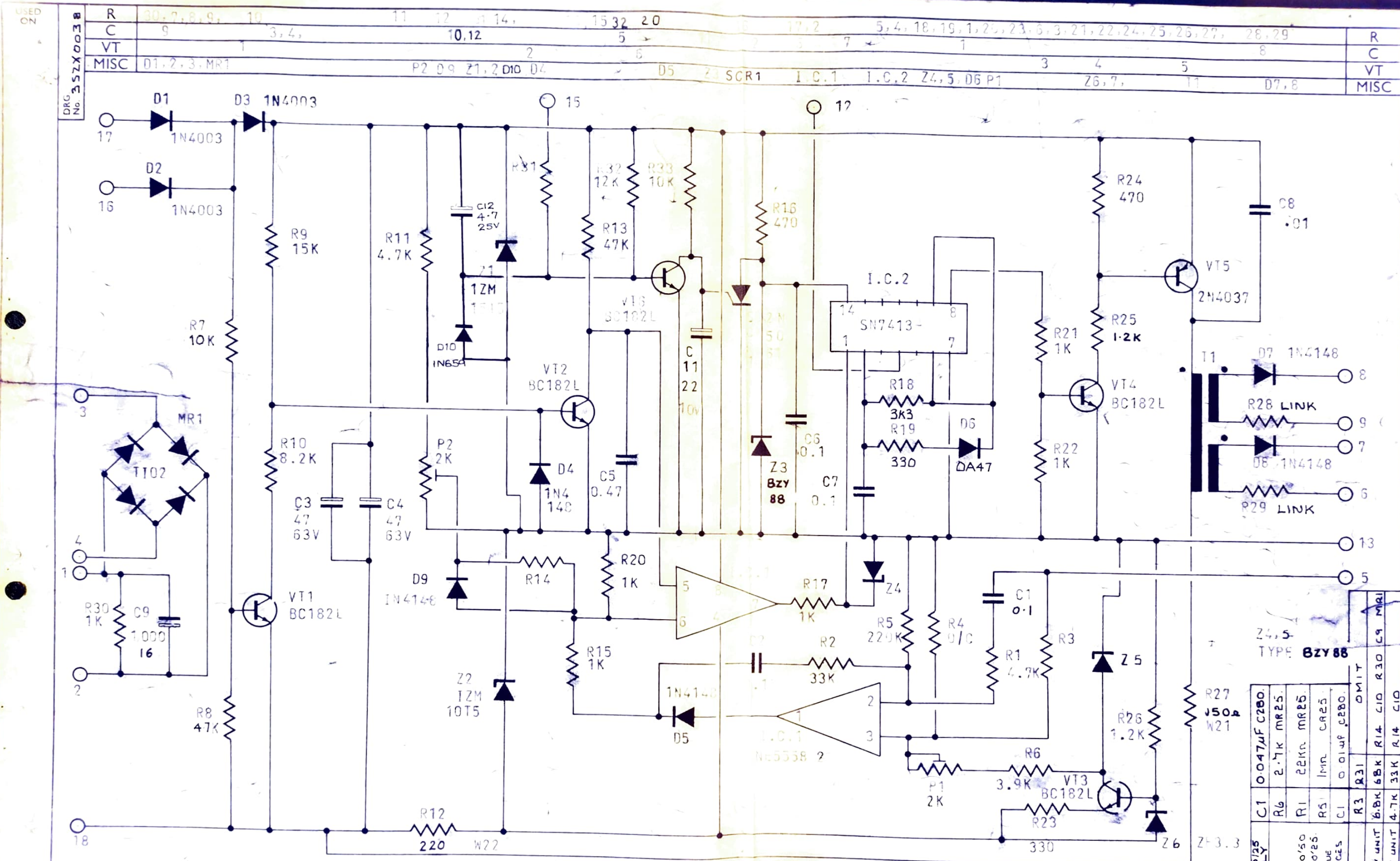
TRACED							
CHECKED	P.G.	B	1-4-74				
DRAWN	M.H.	ISS.	DATE	MOD. No.			
		A	20.9.73				

NOTE —
CAPACITOR VALUES GIVEN IN μF.
RESISTOR VALUES IN Ω
(2) REFERS TO CCT. BD. PIN CONNECTION Nos.

FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

CIRCUIT DIAGRAM
SERIES REGULATOR. H30/100

DRAWING No.
3 ZX 0642 105


DRG No. 35ZX0038
R
C
VT
MISC
D1
1N4003
D2
1N4003
D3 1N4003
R9 15K
R7 10K
R10 8.2K
R8 47K
VT1 BC182L
MR1
T102
R30 1K
C9 1,000 16
C3 47 63V
C4 47 63V
R11 4.7K
C12 4.7 25V
Z1 1ZM
D10 IN654
P2 2K
D9 IN4148
Z2 1ZM 10T5
R12 220
W22
R31
R32 12K
R33 10K
R13 47K
VT2 BC182L
D4 1N4148
C5 0.47
R20 1K
R14
R15 1K
VT6 BC182L
C 11 22 10V
R16 470
SCR1
Z3 BZY 88
C6 0.1
C7 0.1
I.C.2
SN7413
R18 3K3
R19 330
D6 OA47
R17 1K
Z4
R5 220K
R4 O/C
R2 33K
1N4148
D5
I.C.1 NE5558
R21 1K
R22 1K
R24 470
R25 1.2K
VT4 BC182L
VT5 2N4037
C8 .01
T1
D7 1N4148
D8 1N4148
R28 LINK
R29 LINK
C1 0.1
R1 4.7K
R3
Z5
R26 1.2K
Z6
R27 150Ω W21
R6 3.9K
P1 2K
VT3 BC182L
R23 330
Z4,5 TYPE BZY88
H60/25 ONLY
C1 0.047µF C280
R6 2.7K MR25
R1 22KΩ MR25
R5 1MΩ CR25
C1 0.01µF C280
H60/50
H60/25
VALUE CHANGES
60V UNIT: R3 6.8K, R31 68K, R14, C10
30V UNIT: R3 4.7K, R31 33K, R14, C10
OMIT: MR1, C9, R30
17
16
15
12
3
4
1
2
18
8
9
7
6
13
5

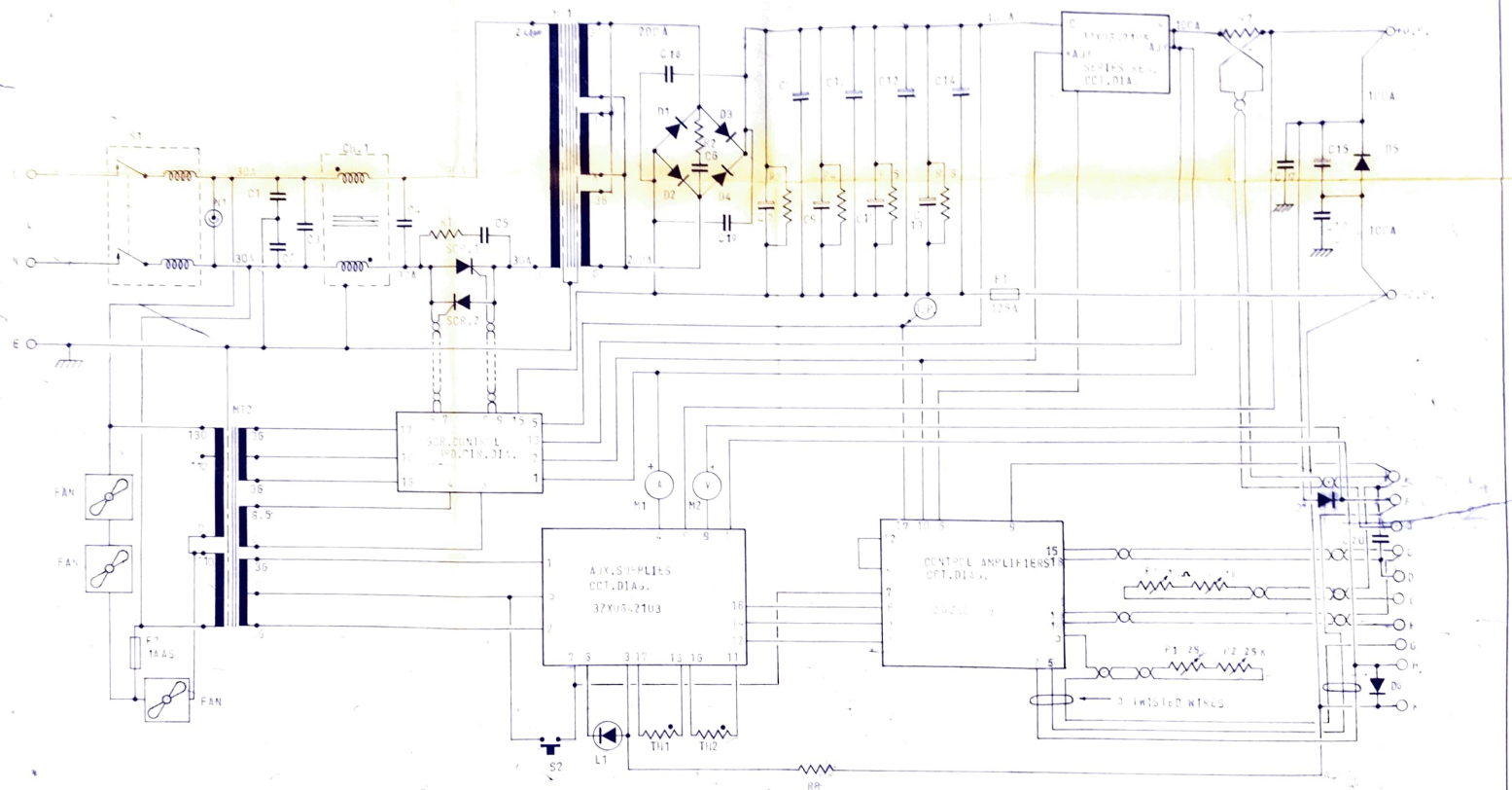
TRACED		E	13.10.75	Q3596	F	8.3.76	Q3787	L 13.6.78 Q4700
		D	9.6.75	Q3409	G	30.3.76	Q3797	
CHECKED		C	15.1.75	Q3320	H	17.8.76	Q3937	
		B	12.12.74	Q3278	I	28.9.76	Q4010	
DRAWN		ISS.	DATE	MOD No.	J	23.11.76	Q4074	

NOTE :-
CAPACITOR VALUES GIVEN IN µF
RESISTOR VALUES IN Ω
(2) REFERS TO CCT. BD. PIN CONNECTION Nos

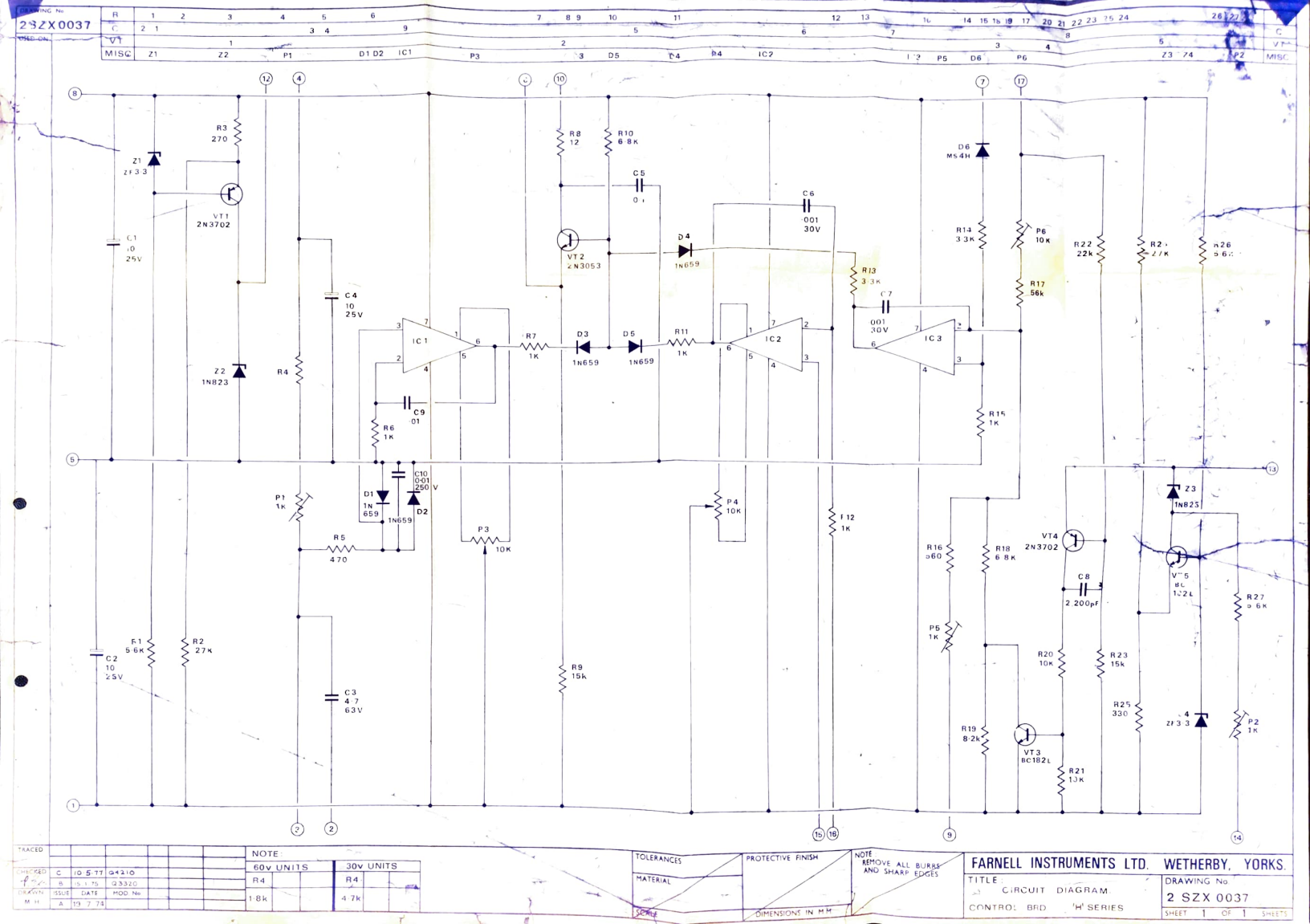
FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

SCR CONTROL CIRCUIT BOARD
CIRCUIT DIAGRAM

DRAWING No.



TRACED	C	6-5-75	3878	TOLERANCES	PROTECTIVE FINISH	NOTE: REMOVE ALL BURRS AND SHARP EDGES	FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.		
	D	3-11-75	03320						
CHECKED	C	11-6-74	02950	MATERIAL			TITLE:	DRAWING No	
DRAWN	B	1-4-74						SHEET 1 OF SHEETS	
	ISSUE	DATE	MOD No	SCALE	DIMENSIONS IN MM				


DRAWING No. 2SZX0037
USED ON
MISC
Z1 ZF3.3
R3 270
VT1 2N3702
C1 10 25V
Z2 1N823
C4 10 25V
R4
IC1
R6 1K
C9 01
R7 1K
D3 1N659
D5 1N659
R11 1K
D1 1N659
D2 1N659
C10 001 250V
P1 1K
R5 470
P3 10K
C2 10 25V
R1 5.6K
R2 27K
C3 4.7 63V
R8 12
R10 6.8K
C5 01
VT2 2N3053
D4 1N659
C6 001 30V
IC2
R9 15K
P4 10K
I 12 1K
R13 3.3K
C7 001 30V
IC3
R15 1K
D6 MS4H
R14 3.3K
P6 10K
R17 56K
R22 22K
R24 27K
R26 5.6K
R16 560
R18 6.8K
VT4 2N3702
C8 2 200pF
P5 1K
R20 10K
R23 15K
R25 330
R19 8.2K
VT3 BC182L
R21 10K
Z3 1N823
VT5 BC182L
R27 5.6K
Z4 ZF3.3
P2 1K
NOTE
60v UNITS
R4
1.8k
30v UNITS
R4
4.7k
TOLERANCES
MATERIAL
SCALE
PROTECTIVE FINISH
DIMENSIONS IN MM
NOTE REMOVE ALL BURRS AND SHARP EDGES
TRACED
CHECKED C 10.5.77 Q4210
B 15.1.75 Q3320
DRAWN M.H. ISSUE A DATE 13.7.74 MOD No
FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.
TITLE CIRCUIT DIAGRAM
CONTROL BRD 'H' SERIES
DRAWING No. 2 SZX 0037
SHEET 1 OF 1 SHEETS